



National Fire Protection Association

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WTC Technical Information Repository
ATTN: Mr. Stephen Cauffman
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Dear Mr. Cauffman:

Several members of the NFPA Technical Staff reviewed the draft report relating to the Federal Building and Fire Safety Investigation of the World Trade Center Disaster. First, NFPA wants to thank Dr. Sunder and his team members for producing such a detailed report. We have made every attempt to provide equally detailed comments and recommended changes or clarifications to the report.

Second, for any of our comments that may seem to be overly critical, our purpose was to make sure the public has as much background as possible on the assumptions or approaches made by the team.

I am looking forward to hearing the presentations and discussions at the Technical Conference on the Federal Building and Fire Safety Investigation of the World Trade Center Disaster in September.

Sincerely,

A handwritten signature in black ink, appearing to read "GK".

Gary Keith
Vice President
Building Codes & Standards/Regional Operations

GK:RES:jtm

C: Dr. Shyam Sunder
Dr. William Grosshandler
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Enclosure: NFPA Comments

NFPA COMMENTS TO NIST ON THE FEDERAL BUILDING AND FIRE SAFETY INVESTIGATION OF THE WORLD TRADE CENTER DISASTER

INTRODUCTION

NFPA is pleased to present comments to NIST on their comprehensive study of the World Trade Center (WTC) disaster. The level of effort, study, analysis and examination of both the known, factual events of September 11, 2001 as well as the circumstances that NIST had to develop a hypothesis for because of a lack of visual or physical evidence, is notable, and unprecedented. The members of the National Construction Safety Team (NCST), the contributing NIST staff, as well as the private contractors and consultants are to be commended for their commitment to this project. Likewise, the public members of the NCST Federal Advisory Committee for their oversight of the project.

The NCST reports will serve as an important framework for the basis of possible changes to many of the NFPA codes and standards in the coming years. Within the 30 recommendations, are issues related to NFPA codes that have either already been revised, are in the process of being revised, or are likely to be revised in some way during future code changes and document revision cycles. It should be noted, however, that it is not only possible, but likely, that after a thorough and detailed analysis of some of the NCST recommendations, there simply may not be enough sufficient detail or compelling evidence to promulgate a change to a particular code or standard. With that said, NFPA is making a commitment to NIST to continue to study, review and evaluate each recommendation before any final decision on a given recommendation is finalized.

The on-going debate about whether building regulations should address events associated with normal building hazards, or more extreme events such as hostile acts and explosions will have to be settled first before consensus is reached on many of the recommendations and findings address in the WTC study. This will be a long term process in most case.

Implementation of many of the recommendations will require significant study and scientific input. NIST is uniquely positioned to help provide this type of information. Much of NIST's effort has focused on the application of computer modeling techniques to mathematically reproduce the events of September 11, 2001. This knowledge and experience should be applied to acquire a greater understanding of the effects of fire.

The comments contained within this document have been prepared by the staff of NFPA and have not been reviewed or endorsed by any of the NFPA Technical Committees or

relevant NFPA advisory committees. That process will occur in the future once the final report is issued.

Our comments have been arranged so as to generally follow the major NCSTAR section and chapter headings of the report. When possible, our comments will refer to specific sections of the NIST study to make sure we have correlated our responses to the recommendations, findings or supplemental information contained within the report. In most cases, NFPA's comments may be as simple as agreeing with the recommendation or finding, agreeing with the recommendation or finding in principle or in some cases, disagreeing with the recommendation or finding. Regardless of our comments on the report, NFPA plans to fully consider the depth and breadth of all of the recommendations in future revision cycles of the relevant NFPA codes and standards, research programs or public education programs and instruction efforts.

SUMMARY

NFPA's Initial Reactions and Comments

The draft report by NIST on 23 June 2005 is what NFPA believes is a very thorough, technical, scientific study of any building loss investigation ever conducted. This report, the second issued under the authority of the National Construction Safety Team Act (NCST), shows that NIST takes its responsibility under the NCST seriously and that NIST is committed, not only to providing a high level of scientific data, but also to providing a set of recommendations for future consideration to codes and standards developers as well. Additionally, NFPA is pleased to see the work effort of NIST resulting in positions on many controversial and sometimes, unpopular subjects. The need to conduct more research in numerous areas is quite clear. In addition, the need to parse the recommendations that may only be appropriate for a September 11, 2001 attack (or similar extreme event) versus lower magnitude events that may have severe consequences is an important distinction.

As NFPA noted in our comments for The Station nightclub investigation: "*The quality, quantity, and depth of information provided in this draft report are indicative of the resources, both human and financial, that NIST has committed to this effort. By this example, NIST has also set a high standard of performance for the future of such building loss investigations.*" is positively true. The WTC study is unprecedented and shows the scientific resources and talent that NIST has at its disposal.

The reports and recommendations released by NIST represent a great first step in setting an agenda for high-rise building design and construction as well as for other structures that may benefit from such technological changes. The 30 recommendations vary greatly in their complexity, ease of integration into codes and standards, or practice and in some cases, their ability to definitively make a difference in some realm or range of building

design hazard. Some of the recommendations should be considered for implementation sooner rather than later; other recommendations will require further study, debate and elaboration; and some others may never realize implementation. In determining what changes go where, and when, consideration should be given to preparing guides or recommended practice documents. Such design options can then be used when deemed necessary by a designer or a government entity on select, but not all projects.

NFPA plans to take full advantage of the effort by NIST. NFPA's efforts will be multi-faceted and will cover many projects, programs and activities within NFPA. In addition, NFPA will also work with collaborators on certain recommendations. In particular, those that may specifically signal the need for more study, more research, or areas where NFPA can interact with some of our allied organizations or constituents. NFPA staff members have already identified areas where our technical committees, membership sections, public education programs, or some combination thereof, can serve as change agents for the subjects determined to be appropriate for change.

Following the release of the final report, NFPA staff will:

- a. Review the report recommendations to determine the best course of action for each, within the NFPA codes and standards process or in other research or education areas within NFPA
- b. Determine the status of each recommendation within NFPA's activities (Some have already been acted on; some are in process; some are not yet developed where NFPA has a clear position.)
- c. Develop a schedule, specifying priorities, for actions on the recommendations

Once the final report is released, a continuing review of the 30 recommendations including the practicality or impracticality of each, the extent to which the recommendation is justified or defined, and the best approach to integrate the recommendation, if feasible, into practice now needs to be the focus of building owners, designers, contractors and code organizations in the coming years.

NFPA's response to this effort to date has primarily been based on NFPA staff input along with some preliminary input from the NFPA High Rise Building Safety Advisory Committee (HRBSAC) and the Disability Access Review and Advisory Committee (DARAC).

NFPA COMMENTS ON THE RECOMMENDATIONS

NFPA has addressed the substance of the NIST report in three ways. First, we have laid out a broad reaction and response to the 30 recommendations. This section provides input and response to NIST and also notes what NFPA committee projects or programs are likely to be asked to look at the details of the related recommendations.

The second part of our response provides comments directly on several of the NCSTAR documents. This portion identifies changes that we believe need to be made to clarify, revise or correct in the final report from NIST.

The third and final section of our comments relates to the methodology used in developing the causal model of the evacuation that is discussed in Appendix C of NCSTAR 1-7.

NFPA'S INITIAL COMMENTS AND REACTIONS

The following are the basic recommendations from NIST and NFPA's initial comment and reaction to the 8 subject groups and 30 recommendations.

Group 1. Increased Structural Integrity

The standards for estimating the load effects of potential hazards (e.g., progressive collapse, wind) and the design of structural systems to mitigate the effects of those hazards should be improved to enhance structural integrity.

Recommendation 1. NIST recommends that: (1) progressive collapse should be prevented in buildings through the development and nationwide adoption of consensus standards and code provisions, along with the tools and guidelines needed for their use in practice; and (2) a standard methodology should be developed—supported by analytical design tools and practical design guidance—to reliably predict the potential for complex failures in structural systems subjected to multiple hazards.

NFPA Comment: This recommendation will need further discussion and debate as it does not stipulate the extent of the multiple hazards to be considered, what load conditions should be assumed, what percentage of load path members would be assumed to be unavailable, and on how many floors those members would be missing.

NFPA believes that progressive collapse should be prevented and that it ultimately should be addressed by building regulations and design methods. However, the concept deserves further study. A clear delineation between what is defined as progressive collapse versus disproportionate collapse must be established and plainly defined.

The degree to which progressive collapse can be addressed is dependent upon the threat/hazard to be considered. Most scenarios would dictate that a progressive collapse of a building would be initiated by a substantial event such as an explosion rather than the type of events considered by current codes. The techniques used to protect against progressive collapse also need to be further analyzed. Mitigation techniques may need to consider more than just the loss of a single column or load path. Additionally, the impact of any potential solutions on other design objectives also needs to be thoroughly considered. This recommendation is of the type that may only be needed to be considered for select icon or symbolic buildings. Any such collapse scenarios, and their associated designs would require a comprehensive risk analysis to better identify the threat/hazard to be protected against. NFPA further believes that the collection of existing data on the

hazard level with respect to progressive collapse is needed, and that other kinds of data such as that which shows how many deaths have resulted from disproportionate collapse also needs to be collected. Policy wise, organizations such as the Structural Engineering Institute of ASCE and the National Council of Structural Engineering Associations (NCSEA) should be tasked with development of key guidelines or manuals to address this concept.

NFPA PROJECTS: Technical Committee on Fundamentals (BLD-FUN); Technical Committee on Structures and Construction (BLD-STR); Technical Committee on Building Construction (BLD-BLC).

Recommendation 2. NIST recommends that nationally accepted performance standards be developed for: (1) conducting wind tunnel testing of prototype structures based on sound technical methods that result in repeatable and reproducible results among testing laboratories; and (2) estimating wind loads and their effects on tall buildings for use in design, based on wind tunnel testing data and directional wind speed data.

NFPA Comment: Comparing state of the practice from 1964 to the tools available in 2002 does not seem to be a fair judgment. Such tools are available and have been in use for decades. This recommendation would seem to be asking for refinement of these tools, but not a mandate to use them. Policy wise, organizations such as the Structural Engineering Institute of ASCE and the National Council of Structural Engineering Associations (NCSEA) should be tasked with development of key guidelines or manuals to address this concept.

NFPA PROJECTS: Technical Committee on Structures and Construction (BLD-STR);

Recommendation 3. NIST recommends that an appropriate criterion should be developed and implemented to enhance the performance of tall buildings by limiting how much they sway under lateral load design conditions (e.g., winds and earthquakes).

NFPA Comment: It would appear that the drift limit criteria associated with seismic design already exists to address this recommendation. Serviceability criteria also would seem to drive this limitation more than wind or seismic design. There is no immediate evidence that something is amiss within this area of tall building design. Policy wise, organizations such as the Structural Engineering Institute of ASCE and the National Council of Structural Engineering Associations (NCSEA) should be tasked with development of key guidelines or manuals to address this concept.

NFPA PROJECTS: Technical Committee on Structures and Construction

Group 2. Enhanced Fire Resistance of Structures

The procedures and practices used to ensure the fire resistance of structures should be enhanced by improving the technical basis for construction classifications and fire resistance ratings, improving the technical basis for standard fire resistance testing methods, use of the “structural frame” approach to fire resistance ratings, and developing

in-service performance requirements and conformance criteria for spray-applied fire resistive materials.

Recommendation 4. NIST recommends evaluating, and where needed improving, the technical basis for determining appropriate construction classification and fire rating requirements (especially for tall buildings greater than 20 stories in height)—and making related code changes now as much as possible—by explicitly considering factors including:

- timely access by emergency responders and full evacuation of occupants, or the time required for burnout without local collapse;
- the extent to which redundancy in active fire protection (sprinkler and standpipe, fire alarm, and smoke management) systems should be credited for occupant life safety;
- the need for redundancy in fire protection systems that are critical to structural integrity;
- the ability of the structure and local floor systems to withstand a maximum credible fire scenario without collapse, recognizing that sprinklers could be compromised, not operational, or non-existent;
- compartmentation requirements (e.g., 12,000 ft²) to protect the structure, including fire rated doors and automatic enclosures, and limiting air supply (e.g., thermally resistant window assemblies) to retard fire spread in buildings with large, open floor plans;
- the impact of spaces containing unusually large fuel concentrations for the expected occupancy of the building; and
- the extent to which fire control systems, including suppression by automatic or manual means, should be credited as part of the prevention of fire spread.

NFPA Comment: Ideas in this recommendation are continuously under review, scrutiny and debate—and not just for tall buildings. The fact is, we have had excellent performance in high-rise building fires when the combination of passive and active features was present. The recent history of high-rise building fire that included total or near total burnout of significant parts the structure, including Meridian Plaza (1991); Parque Central (2004) Windsor Towers (2005) would suggest that we are doing much of this at present. These buildings sustained long duration fires (18 plus hours) without suffering global collapse. This recommendation can, and should, be used to determine if such sustained burnouts are acceptable, and if demolition of the structure after the event is an acceptable property, financial and economic loss.

NFPA is in general agreement with the recommendation that a more technical basis for the determination and use of construction classifications be pursued, and notes that NFPA has and continues to pursue this overall objective through its codes and standards development process. NFPA understands this comment to mean that NIST has not indicated that there is a problem with the current system of construction classification but that the current system should be based on a more technical and scientific basis.

More specifically, NFPA believes that the ultimate successful implementation of this recommendation is largely dependent upon how some of the other recommendations are addressed. For example, re-considering the determination of construction type, which is dependent upon the test method utilized to arrive at a fire resistance rating, cannot be pursued until the test protocols are evaluated, as suggested by NIST Recommendation #5. With regard to considering specific factors as identified in the bulleted items of Recommendation #4, these also cannot be properly addressed until other

recommendations are considered. For instance, the timely evacuation of occupants in bullet item one would be a function of the potential use of new evacuation means such as the use of elevators as noted in recommendation #20. The very complex and interconnected issues raised by Recommendation #4 are in need of further study. Performance and reliability of automatic sprinkler systems in Recommendation 12 seems to be called into question, which will impact any changes derived from Recommendation 4. Automatic sprinkler performance has been , and continues to be excellent. A more specific research agenda and procedure in addressing this very comprehensive recommendation needs to be developed.

With regard to further categorizing tall buildings based upon height, NFPA believes that this subject deserves more immediate attention and should be specifically addressed based upon the current construction classification system, and then re-evaluated if a new approach for construction classification is developed. One suggestion that NFPA will pursue is to look at a segmentation of high rise building levels and determine if a risk indexing system may be implemented based upon a certain height category. All NFPA technical committees responsible for NFPA 101 and NFPA 5000 should provide further input as any such categorization may be occupancy dependent.

NFPA also notes that the basis for requiring a certain type of construction classification is a function of the threats/hazards to be protected against. The types of threats/hazards to be considered by building regulations and building designs need to be better quantified. NFPA's Technical Committee on Fundamentals (BLD-FUN) and NFPA's occupancy committees could provide further input in this regard.

A small, but important point (the sixth bullet) in this recommendation is crucial and does need will require attention as it relates to location and placement of day tanks and routing of the fuel lines to emergency generators and fire pumps in all structures. NFPA agrees that consideration must be given to the impact on a building structure due to the presence of unusually large amounts of hydrocarbon fuel, such as was stored in WTC 7 for the numerous emergency generators located in WTC 7. Continuous discharge of fuel for these generator sets may have contributed to the collapse of WTC 7 once one or more of the fuel lines failed allowing the fuel to be ignited and burn unimpeded.

NFPA requirements for storage of liquid fuel inside a building for the operation of stationary engine-driven or stationary turbine-driven equipment (e.g., fire pumps, electric generators) are contained in Chapters 6, Fuel Supply – Liquid, of NFPA 37-2002, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*. The requirements are similar but not identical to the requirements in the Building Code of the City of New York (BCNYC).

Several issues identified in Chapter 12 of NCSTAR 1-1 need to be considered and studied by NFPA's Technical Committee on Internal Combustion Engines, including but not limited to the following:

- Maximum fuel storage capacity allowed unenclosed, i.e., not in a dedicated enclosure. This includes so-called base tanks and day tanks.
- Maximum fuel storage capacity allowed in dedicated fire-rated enclosures and the required fire resistance of the enclosure walls, floor, and ceiling.
- Need for active fire suppression systems designed for the quantity of fuel present.
- Need for specific protection requirements for fuel piping leading from lower floor storage tanks to upper floor stationary engines. (NOTE: NFPA 37 simply refers to NFPA 30-2003, *Flammable and Combustible Liquids Code*, for piping design and installation. NFPA 30 does not contain specific requirements that fuel piping in a building be contained within a dedicated shaft.)
- Need for specific piping system components to shut down fuel supply pumps if a break in the piping occurs.

NFPA 37 is currently being revised and the next edition is scheduled for publication in the first Quarter, 2006. The Technical Committee on Internal Combustion Engines will address these issues during the next document revision cycle.

As with other recommendations, NFPA notes that this recommendation and its associated bulleted items calls for the greater use and application of risk and hazard analyses for building design, and that the factors identified by NIST in the recommendation be considered in these analyses. Many of the tools and data needed to properly conduct this risk evaluation might not be available at present thus presenting some unique challenges as this effort moves forward.

NFPA understands that the bulleted items are intended to serve as factors which might or should be considered in the determination and use of construction types, and that the bulleted items are not intended to serve as stand alone recommendations.

NFPA views these recommendations as long term objectives which will result in a more technical and scientific basis for building regulations.

NFPA PROJECTS: All Technical Committees responsible for NFPA 101 and NFPA 5000 (BLD-AAC, SAF-AAC); Technical Committee on Flammable and Combustible Liquids (FLC-AAC); Technical Committee on Emergency Power Supplies (EPS-AAA); Technical Committee on Internal Combustion Engines (INT-AAA).

Recommendation 5. NIST recommends that the technical basis for the century-old standard for fire resistance testing of components, assemblies, and systems should be improved through a national effort. Necessary guidance also should be developed for extrapolating the results of tested assemblies to prototypical building systems.

NFPA Comment: While the test protocols have been used for a very long time, there is nothing striking or remarkably wrong with the tests. The third bullet item under Part a. has been a focal point of the AISC Fire Engineering Committee since May of 2001. In other cases, the need to evaluate construction assemblies under simulated load conditions has also been in discussion. A review of the NFPA 251/ASTM E119/ UL 263 time-temperature curve in comparison to the data that has been collected in real world laboratory fires is reasonable to determine if these test protocols should be modified.

NFPA is in agreement with this recommendation for improving the technical basis for determining fire resistance ratings. NFPA notes that pursuing this recommendation might result in less fireproofing in some instances and more fireproofing in other cases as the current test procedure (NFPA 251/ ASTM E119/UL 263) is considered by many to be conservative on a macro scale even though it does not completely address details such as connection methods. The implementation of this recommendation will require further study and additional research. As a part of the evaluation of these test procedures, a joint effort by NFPA, ASTM and UL will be proposed by the Fire Protection Research Foundation (FPRF) to study the issues, the similarities and the differences between the test protocols versus actual fires and relevant ISO standards to determine if the test protocols need to be or should be changed.

NFPA PROJECTS: Technical Committee on Fire Protection Features (BLD-FIR); Technical Committee on Fire Tests (FIR-AAA); Fire Protection Research Foundation.

Recommendation 6. NIST recommends the development of criteria, test methods, and standards: (1) for the in-service performance of spray-applied fire resistive materials (SFRM, also commonly referred to as fireproofing or insulation) used to protect structural components; and (2) to ensure that these materials, as-installed, conform to conditions in tests used to establish the fire resistance rating of components, assemblies, and systems.

NFPA Comment: Quality control associated with field preparation and application of SFRM is a legitimate concern. Firestop Contractors International Association (FCIA) has initiated work on standards and procedures to address this particular need. These standards, once completed, should be recognized and adopted by models codes and standards. The life of use issue associated with SFRM is also critical. Inspection procedures, on site repair and environmental exposure are all key factors in determining the effectiveness of the material.

NFPA is in agreement with this recommendation to improve the overall performance of SFRM. Further, it is noted that in addition to the specific items listed in the recommendation, particular attention should be given to the application of fireproofing on all structural shapes and sizes. Fire service representatives on NFPA's HRBSAC expressed specific concern with regard to small diameter structural elements such as bar joists. SFRM standards from organization such as FCIA and AWCI should be reviewed for reference by NFPA 5000 and NFPA 101. A need to address the appropriate criteria for abrasion, vibration, shock and impact of SFRM under expected service conditions

also exists. Enforcement of the integrity of SFRM throughout the life of the building also needs to be addressed by this recommendation.

NFPA PROJECTS: Technical Committee on Fire Protection Features (BLD-FIR); Technical Committee on Fire Tests (FIR-AAA); Technical Committee on Structures and Construction (BLD-STR); Technical Committee on Building Construction (BLD-BLC); Technical Committee on Fire Prevention Code (UFC-AAA).

Recommendation 7. NIST recommends the nationwide adoption and use of the “structural frame” approach to fire resistance ratings.

NFPA Comment: This approach, now recognized in both model building codes, simply addresses the potential for a “weakest link”. While the basis of the recommendation is now addressed in the 2006 edition of NFPA 5000, the term “structural frame” should be better defined for future editions of the model codes. For example, is the term to include the full load path of all structural members? Thermal failure of a beam or girder connected to a main support column carrying a gravity load-and that is essential to the stability of the structure-can impact the load path. This recommendation only addresses that particular scenario.

NFPA PROJECTS: Technical Committee on Structures and Construction (BLD-STR); Technical Committee on Building Construction (BLD-BLC); Technical Committee on Fire Tests (FIR-AAA).

Group 3. New Methods for Fire Resistance Design of Structures

The procedures and practices used in the fire resistance design of structures should be enhanced by requiring an objective that uncontrolled fires result in burnout without local or global collapse. Performance-based methods are an alternative to prescriptive design methods. This effort should include the development and evaluation of new fire resistive coating materials and technologies and evaluation of the fire performance of conventional and high-performance structural materials. Technical and standards barriers to the introduction of new materials and technologies should be eliminated.

Recommendation 8. NIST recommends that the fire resistance of structures should be enhanced by requiring a performance objective that uncontrolled building fires result in burnout without local or global collapse.

NFPA Comment: This recommendation lumps two very different outcomes together—that being total burnout without local or global collapse. The fire events noted in Recommendation 4 did result in local, but not global collapse. The design level of preventing local collapse during a total burnout does not appear to be realistic unless the current cadre of expected fire scenarios are enhanced and made substantially more conservative. This would result in system redundancies and robustness that will LIKELY be difficult to justify from an economic and experiential point of view. Global collapse from a typical or anticipated fire event is certainly an unwanted outcome—but such cases simply do not exist for the high-rise building environment. NFPA suggests that this

recommendation be parsed to separately address local collapse (which seems more acceptable) from global collapse (which seems wholly unacceptable)

A need exists to better define what is meant by “uncontrolled building fires”. Is it intended that this term include only those types of fires already addressed by building and fire regulations, or is it to include other threats/hazards such as hostile acts and explosions? NFPA notes that where building collapses have occurred as a result of fire, the failures were primarily a result of the inadequate application of code mandated provisions and maintenance of fire protection features rather than from any shortcoming associated with building regulations or design methods.

NFPA PROJECTS: Technical Committees on Structures and Construction (BLD-STR), Technical Committees on Building Construction (BLD-BLC); Technical Committee on Fundamentals (BLD-FUN); Technical Committee on Fire Risk Assessment Methods (FIR-AAA)

Recommendation 9. NIST recommends the development of: (1) performance-based standards and code provisions, as an alternative to current prescriptive design methods, to enable the design and retrofit of structures to resist real building fire conditions, including their ability to achieve the performance objective of burnout without structural or local floor collapse; and (2) the tools, guidelines, and test methods necessary to evaluate the fire performance of the structure as a whole system.

NFPA Comment: Performance Based Design (PBD) methods already exist in NFPA 1, NFPA 101 and NFPA 5000. These can be applied equally to new construction or existing buildings. The same discussion with respect to local and global collapse (Recommendation 8) also applies here. PBD will also have to be measured against prescriptive design to assure it is not providing a lower level of performance in any manner.

NFPA believes that ongoing efforts are needed in the development of tools, data and training for the better implementation of performance-based design methods.

NFPA PROJECTS: Technical Committee on Fundamentals (BLD-FUN).

Recommendation 10. NIST recommends the development and evaluation of new fire resistive coating materials, systems, and technologies with significantly enhanced performance and durability to provide protection following major events.

NFPA Comment: This recommendation should not be de-coupled from recommendation No. 6. There are no technical barriers that NFPA is aware of to such systems or materials and NFPA agrees with this recommendation that new building materials be evaluated for their fire resistant characteristics. The testing and listing laboratories such as UL, FM Global, Omega Point and Southwest have the ability to test innovative materials.

NFPA PROJECTS: Technical Committee on Fire Tests (FIZ-AAA); Technical Committee on Building Construction (BLD-BLC).

Recommendation 11. NIST recommends that the performance and suitability of advanced structural steel, reinforced and pre-stressed concrete, and other high-performance material systems should be evaluated for use under conditions expected in building fires.

NFPA Comment: Use of material such as fire resistive steel (FRS), concrete filled tube (CFT) and use of similar existing innovations (water filled tube WFT) have the potential to become more mainstream. Provided any of the materials or composites provides the same or higher level of protection than the current offering of construction materials, such options should be considered and more fully developed. NFPA comments on Recommendation 10 also apply here.

NFPA PROJECTS: Technical Committee on Fire Tests (FIZ-AAA); Technical Committee on Building Construction (BLD-BLC); Fire Protection Research Foundation

Group 4. Improved Active Fire Protection

Active fire protection systems (i.e., sprinklers, standpipes/hoses, fire alarms, and smoke management systems) should be enhanced through improvements to design, performance, reliability, and redundancy of such systems.

Recommendation 12. NIST recommends that the performance and redundancy of active fire protection systems (sprinklers, standpipes/hoses, fire alarms, and smoke management systems) in buildings should be enhanced to accommodate the greater risks associated with increasing building height and population, increased use of open spaces, available compartmentation, high-risk building activities, fire department response limits, transient fuel loads, and higher threat profile.

NFPA Comment: This recommendation should be broken down into a broader category—namely to look at various risks associated with various segments of tall buildings. While the recommendations are appropriate to look at, other parts of the report only seem to focus on a 20 story differentiation. Consideration of a schedule for high rise buildings (perhaps 4 or 5 categories—see NFPA comments on related subject in Recommendation 4) would be more appropriate. The taller the building, i.e. the greater the perceived risk , construction features and systems with added redundancies or robustness of systems could be increased in some manner.

A means for better understanding and quantifying the impact, performance and reliability of fire protection systems should be pursued. A distinction should also be emphasized between enhancing the effectiveness of such systems and evaluating their appropriateness with respect to specific hazards/threats.

One starting point to consider, revolves around the CTBUH *Building Enhancement Guidelines*. These guidelines, released in May of 2002 provide potential augmentation features that could be applied to increase the reliability of certain building systems and

features. In this realm, the systems would be enhanced or hardened to be able to manage certain design hazards that are normally not contemplated in codes. The NFPA HRBSAC is considering a concept (modeled on the LEEDS system) that would provide a point score system for certain system features or enhancements that are best described as “code-plus” designs. Work in this area will likely be in collaboration with NIST and CIB.

It should be noted that the Technical Correlating Committee for the National Electrical Code (NEC) has established a task group to specifically look at the hazard scenarios identified by DHS and to determine what (and where) enhancements to building electrical services could be made to increase the reliability/robustness of such systems.

NFPA PROJECTS: Technical Correlating Committee on Automatic Sprinklers (AUT-AAC); Technical Committee on Fire Pumps (FIM-AAA); Technical Committee on Standpipes (SPI-AAA); Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC); Technical Correlating Committee on National Electrical Code (NEC-AAC); Technical Committee on Emergency Power Supplies (EPS-AAA); Technical Committee on Smoke Management Systems (SMO-AAA).

Recommendation 13. NIST recommends that fire alarm and communications systems in buildings should be developed to provide continuous, reliable, and accurate information on the status of life safety conditions at a level of detail sufficient to manage the evacuation process in building fire emergencies, and that standards for their performance be developed.

NFPA Comment: Timelines of accurate information for the occupants during large scale building emergencies is of crucial importance. The hardware and software necessary to achieve this is available. Knowing when to give direction, and what direction to give is of paramount importance. This recommendation is closely aligned with Recommendation 16 and 19.

NFPA PROJECTS: Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC).

Recommendation 14. NIST recommends that control panels at fire/emergency command stations in buildings should be adapted to accept and interpret a larger quantity of more reliable information from the active fire protection systems that provide tactical decision aids to fireground commanders, including water flow rates from pressure and flow measurement devices, and that standards for their performance be developed.

NFPA Comment: The benefit of having flow rate data available at the command center is not obvious. What other information was being considered when this recommendation was being drafted?

NFPA PROJECTS: Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC); Technical Correlating Committee on

Automatic Sprinklers (AUT-AAC); Technical Committee on Fire Service Occupational Safety (FIX-AAA).

Recommendation 15. NIST recommends that systems should be developed and implemented for: (1) real-time off-site secure transmission of valuable information from fire alarm and other monitored building systems for use by emergency responders, at any location, to enhance situational awareness and response decisions and maintain safe and efficient operations³²; and (2) preservation of that information either off-site or in a black box that will survive a fire or other building failure for purposes of subsequent investigations and analysis. Standards for the performance of such systems should be developed, and their use should be required.

NFPA Comment: Alarm transmission information is routinely backed up and available at central station monitoring facilities. If the only purpose for having this is for event reconstruction, such data already exists in most cases. If it is for use during an event, a point of information overload may be reached. Under some circumstances, too much information becomes less than useful. NIST should particularly pay attention to comments from fire department personnel and OEM managers on this recommendation.

NFPA PROJECTS: Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC); Technical Committee on Fire Service Occupational Safety (FIX-AAA).

Group 5. Improved Building Evacuation

Building evacuation should be improved to include system designs that facilitate safe and rapid egress, methods for ensuring clear and timely emergency communications to occupants, better occupant preparedness for evacuation during emergencies, and incorporation of appropriate egress technologies.

Recommendation 16. NIST recommends that public agencies, non-profit organizations concerned with building and fire safety, and building owners and managers should develop and carry out public education campaigns, jointly and on a nationwide scale, to improve building occupants' preparedness for evacuation in case of building emergencies.

NFPA Comment: This type of action should have been standard protocol pre September 11. High rise building evacuation is a complex subject and while partial relocation of occupants is still the preferred method, we now know that:

- A. It may not always be the preference of the occupant;
- B. Some building events-fire, power failure, bomb threat-require special approaches, and a full building evacuation may be needed.

At present, NFPA does offer guidelines, both in pamphlet form and on the NFPA website concerning evacuation protocols from high rise buildings. NFPA will pursue the development of additional education programs in this regard and establish cooperative agreements with other organization that have similar interests (BOMA, CTBUH, GSA, ULI). In all cases, any such programs or educational initiatives must be inclusive of persons with all manner of disabilities. See related item in Recommendation 20.

NFPA PROJECTS: Technical Correlating Committee on Safety to Life (SAF-AAC); Technical Committee on Fire Prevention Code (UFC-AAA); Public Education Section; DARAC.

Recommendation 17. NIST recommends that tall buildings should be designed to accommodate timely full building evacuation of occupants due to building-specific or large-scale emergencies such as widespread power outages, major earthquakes, tornadoes, hurricanes without sufficient advanced warning, fires, accidental explosions, and terrorist attack. Building size, population, function, and iconic status should be taken into account in designing the egress system. Stairwell and exit capacity should be adequate to accommodate counter flow due to emergency access by responders.

NFPA Comment: Full building evacuation concepts are an important consideration, but should not be viewed as the preferred or optimum choice for a tall building. Width of stairs in high rise buildings has been a discussion topic for decades, not years. While the concept of sizing the stairs for the largest floor population is workable for typical or expected scenarios, there are definitive concerns for mass evacuation of the building coupled with issues of counter-flow by first responders. The 2006 editions of NFPA 101 and NFPA 5000 include a new stair width design concept that incorporates cumulative population use of the stairs. An aggregate of the floor populations will trigger an increase in stair width (from 44 inches to 56 inches) where 2000 or more occupants are expected to use a given stair.

NFPA does believe that a better understanding of the evacuation and egress of building occupants is necessary. Data and methods need to be further developed to help understand occupant behavior and to determine the length of time needed to evacuate building occupants. Scenarios should include various types of evacuation such as partial evacuation or relocation concepts, full evacuation, defend in place concepts, use of elevators, escape devices, and other alternate means of escape. Availability and reduction of egress routes should be also considered. NFPA notes that the term "timely" is largely a function of the threat/hazard to be considered and is likely to require risk analysis. Building-specific and large-scale emergencies need to be quantified. It should also be recognized that rapid evacuation of all building occupants could place them in greater danger. The effect of evacuation planning and drills should be quantified, and efforts in limiting the number of trips and falls should also be pursued.

NFPA PROJECTS: Technical Committee on Means of Egress (BLD/SAF-MEA); Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC); Technical Committee on Fire Service Occupational Safety (FIX-AAA); Research Section; Fire Service Section, Public Education Section.

Recommendation 18. NIST recommends that egress systems should be designed: (1) to maximize remoteness of egress components (i.e., stairs, elevators, exits) without negatively impacting the average travel distance; (2) to maintain their functional integrity and survivability under foreseeable building-specific or large-scale emergencies; and (3) with

consistent layouts, standard signage, and guidance so that systems become intuitive and obvious to building occupants during evacuations.

NFPA Comment: This recommendation is disconcerting in that it introduces a major assumption of a ‘large scale’ emergency, yet states in item b. this is not an aircraft impact. What event(s) would fit into this category? The recommendation also attempts to sweep into it design of other systems and features such as elevators. NFPA recommends that the subject in Recommendation 18 regarding “large scale” emergency be removed from the list and described as a separate point of philosophical discussion. The on-going debate about whether building regulations should address events associated with normal building hazards, or more extreme events such as hostile acts and explosions will have to be settled first before consensus is reached on this subject.

NFPA agrees with that part of the recommendation regarding consistent layout and signage and the use of features that will make the egress system more intuitive. NFPA 72, *National Fire Alarm Code*, has accepted a series of proposals for the 2007 edition that will introduce the concept of *Exit Marking Audible Notification Appliances*. Such components have the ability to direct occupants by sound to the exit locations.

NFPA also agree that remoteness of exits should be studied, as current remoteness provisions might not be adequate for other than fire events. Areas that NFPA Technical Committees will study include concepts of a more robust building core, or more robust stair construction and the reduction of remoteness of exits in sprinklered buildings.

NFPA PROJECTS: Technical Committee on Means of Egress (BLD/SAF-MEA); Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC).

Recommendation 19. NIST recommends that building owners, managers, and emergency responders develop a joint plan and take steps to ensure that accurate emergency information is communicated in a timely manner to enhance the situational awareness of building occupants and emergency responders affected by an event. This should be accomplished through better coordination of information among different emergency responder groups, efficient sharing of that information among building occupants and emergency responders, more robust design of emergency public address systems, improved emergency responder communication systems, and use of the Emergency Broadcast System (now known as the Integrated Public Alert and Warning System) and Community Emergency Alert Networks.

NFPA Comment: This subject closely aligns with Recommendation 13. Similar technologies are deployed at the US Capitol complex to provide an alert status to the approximately 30,000 staff, occupants and visitors who may be present on a given day. Recent work underway at NFPA, and that was initiated at the request of the US Air Force on Mass Notification systems will help to codify and standardize some of these protocols.

NFPA PROJECTS: Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC); Technical Committee on Building Systems (BLD-SYS); Fire Service Section; Public Education Section; Metro Chiefs.

Recommendation 20. NIST recommends that the full range of current and next generation evacuation technologies should be evaluated for future use, including protected/hardened elevators, exterior escape devices, and stairwell navigation devices, which may allow all occupants an equal opportunity for evacuation and facilitate emergency response access.

NFPA Comment: This subject was part of the theme at a NIST sponsored workshop in 2004. Recommendation 21 on elevator use is going to happen sooner rather than later. Last resort escape devices are gaining some recognition and use, but integration of such devices into the built environment must be carefully managed. And there can be no expectation, however, that current technologies will have an impact on September 11 type events.

The term “stairway descent devices” has been used in NFPA 101 and NFPA 5000, and it is recommended that NIST use the same terminology in lieu of stairwell navigation devices.

NFPA PROJECTS: Technical Committee on Means of Egress (BLD/SAF-MEA); Technical Committee on Building Systems (BLD-SYS); DARAC; Public Education Section.

Group 6. Improved Emergency Response

Technologies and procedures for emergency response should be improved to enable better access to buildings, response operations, emergency communications, and command and control in large scale emergencies.

Recommendation 21. NIST recommends the installation of fire-protected and structurally hardened elevators to improve emergency response activities in tall buildings by providing timely emergency access to responders and allowing evacuation of mobility-impaired building occupants. Such elevators should be installed for exclusive use by emergency responders during emergencies. In tall buildings, consideration also should be given to installing such elevators for use by all occupants.

NFPA Comment: Broad use of elevators well into a building fire or other emergency event will offer a means of attaining a more timely evacuation of very tall buildings as noted in Recommendation 17. Work in this particular area is likely within three years of completion and implementation. If possible, NIST and ASME should fast track this particular project so as to allow the hardened elevator concept to be realized sooner if possible.

The effort being organized by NIST and ASME is of crucial importance to ensure that current technology (both hardware and software) can adequately address the associated safety, functional and operational concerns with using the elevators as described. In particular, concerns with elevator shunt trips, the filling of shafts with smoke, the

operation of equipment under adverse conditions such as when wet from fire suppression operations or systems and the need to provide direction to the occupants must be addressed.

A dedicated use elevator as described only for the exclusive use of emergency responders, i.e. fire fighters is open to discussion. In some cases, on site fire ground operations in a high-rise building may take 15 to 20 minutes to commence from time of the first alarm. If a goal truly is to strive for timely evacuation, this is a significant portion of time where the elevators may be in recall mode and are not being utilized. Keeping elevators available for use by building occupants, or at least building occupants with mobility impairments, during this time period, vastly improves the chances of meeting Recommendations 17 and 21.

NFPA suggests that the use elevators should be as a minimum, under exclusive authority of the fire service and other first responders such as fire wardens, security personnel and other authorized on site personnel who may be adequately trained to use the elevator. Ideally, use of the elevators by the occupants should be a longer term goal to strive for. In particular, anything that can be done allow mobility impaired occupants access and use of the elevators under emergency conditions should be pursued as quickly as possible.

Structurally hardened (properly protected) elevators also need to be further defined as well as the threats/hazards to be considered. The CTBUH *Emergency Evacuation Elevator Systems Guideline* (September 2004) provides a definitive starting point for elevator evacuation concepts.

NFPA PROJECTS: Technical Committee on Means of Egress (BLD/SAF-MEA); Technical Committee on Building Systems (BLD-SYS); Technical Committee on Uniform Fire Code (UFC-AAA); Technical Committee on Fire Service Occupational Safety (FIX-AAA); DARAC; Public Education Section; Fire Service Section; Metro Chiefs.

Recommendation 22. NIST recommends the installation, inspection, and testing of emergency communications systems, radio communications, and associated operating protocols to ensure that the systems and protocols: (1) are effective for large-scale emergencies in buildings with challenging radio frequency propagation environments; and (2) can be used to identify, locate, and track emergency responders within indoor building environments and in the field.

NFPA Comment: First responder communication systems must be robust enough to allow uninterrupted, reliable communication between fire, police and OEM officials for all building emergencies and not just the large scale event mentioned. The particular problem of needing reliable and dependable communication systems that work from inside of any building environment to both internal and external locations is crucial.

NFPA PROJECTS: Technical Committee on Fire and Emergency Service Organization and Deployment — Career (ESR-AAA); Technical Committee on Fire and Emergency Service Organization and Deployment — Volunteer ;Technical Committee on Fire

NFPA PROJECTS: Technical Committee on Fire and Emergency Service Organization and Deployment — Career (FAC-AAA); Technical Committee on Fire and Emergency Service Organization and Deployment — Volunteer (FAD-AAA); Technical Committee on Fire Service Occupational Safety (FIX-AAA); Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC); Technical Committee on Public Emergency Service Communication (PUF-AAA); National Electrical Code Committee (NEC-AAC); Fire Service Section; Metro Chiefs.

Recommendation 23. NIST recommends the establishment and implementation of detailed procedures and methods for gathering, processing, and delivering critical information through integration of relevant voice, video, graphical, and written data to enhance the situational awareness of all emergency responders. An information intelligence sector should be established to coordinate the effort for each incident.

NFPA Comment: Related to Recommendations 15, this concept must remain manageable by that individual or sector. One concern may be too much information.

NFPA PROJECTS: Technical Committee on Fire and Emergency Service Organization and Deployment — Career (FAC-AAA); Technical Committee on Fire and Emergency Service Organization and Deployment — Volunteer (FAD-AAA); Technical Committee on Fire Service Occupational Safety (FIX-AAA); Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC); Technical Committee on Public Emergency Service Communication (PUF-AAA); Technical Committee on Pre-Incident Planning (PIP-AAA); Fire Service Section; Metro Chiefs.

Recommendation 24. NIST recommends the establishment and implementation of codes and protocols for ensuring effective and uninterrupted operation of the command and control system for large-scale building emergencies.

NFPA Comment: Circumstances by which a governmental entity establishes a command authority that is event dependent is critical. Smaller jurisdictions may have a one stop procedure-regardless of the event. Larger jurisdictions may have a complex system that has different lead agencies for different events. Such protocols should consider the event, mutual aid from surrounding jurisdictions, and thresholds for assistance from state and federal government agencies.

Jurisdictions at all levels need to develop and implement protocols that clear lines of authority are established in advance of major emergencies. The recommendations made in the report very clearly outline the steps that jurisdictions should take to improve their command and control of large-scale incidents.

NFPA PROJECTS: Technical Committee on Fire and Emergency Service Organization and Deployment — Career (FAC-AAA); Technical Committee on Fire and Emergency Service Organization and Deployment — Volunteer (FAD-AAA); Technical Committee on Fire Service Occupational Safety (FIX-AAA); Technical Committee on Public Emergency Service Communication (PUF-AAA); Technical Committee on Pre-Incident Planning (PIP-AAA); Fire Service Section; Metro Chiefs.

Group 7. Improved Procedures and Practices

The procedures and practices used in the design, construction, maintenance, and operation of buildings should be improved to include encouraging code compliance by nongovernmental and quasi-governmental entities, adoption and application of egress and sprinkler requirements in codes for existing buildings, and retention and availability of building documents over the life of a building.

Recommendation 25. Nongovernmental and quasi-governmental entities that own or lease buildings and are not subject to building and fire safety code requirements of any governmental jurisdiction are nevertheless concerned about the safety of the building occupants and the responding emergency personnel. NIST recommends that such entities should be encouraged to provide a level of safety that equals or exceeds the level of safety that would be provided by strict compliance with the code requirements of an appropriate governmental jurisdiction. To gain broad public confidence in the safety of such buildings, NIST further recommends that it is important that as-designed and as-built safety be certified by a qualified third party, independent of the building owner(s). The process should not use self-approval for code enforcement in areas including interpretation of code provisions, design approval, product acceptance, certification of the final construction, and post-occupancy inspections over the life of the buildings.

NFPA Comment: The recommendation should also extend to federal agencies as well. This recommendation is simply good practice-both business and neighbor. The terms “non-governmental and quasi-governmental” should be deleted. Additionally it should address those situations where no Authority Having Jurisdiction exists, where the local governing building regulations do not need to be adhered to by the party constructing the building, and where self-certification in the private sector occurs.

NFPA PROJECTS: Technical Committee on Fundamentals (BLD/SAF-FUN); Technical Committee on Uniform Fire Code (UFC-AAA); IFMA; AEBO Section

Recommendation 26. NIST recommends that state and local jurisdictions should adopt and aggressively enforce available provisions in building codes to ensure that egress and sprinkler requirements are met by existing buildings. Further, occupancy requirements should be modified where needed (such as when there are assembly use spaces within an office building) to meet the requirements in model building codes.

NFPA Comment: While retroactive imposition of building safety standards can be intrusive, it is none-the-less good practice. Grandfathering concepts that allow other than imminent hazards to remain in place have proven to be problematic. At first pass, this recommendation needs to be modified somewhat to distinguish between removal of grandfathering clauses and complying with requirements for new construction during renovation type projects. The thresholds' for change is quite different in these two concepts.

Certain requirements for existing buildings such as those pertaining to sprinkler protection and fire resistance should meet the same level of safety required for new construction when a renovation is contemplated. Additional regulations for existing buildings, such as those currently found in NFPA 101, should be developed and adopted. NFPA 101 does not recognize the “grandfathering concept”—instead, it mandates a minimum level of safety and performance that applies retroactively to a building. NFPA is strongly in support of the recommendation that high rise buildings be retrofitted with automatic sprinkler systems. This provision is currently a requirement of NFPA 1 and NFPA 101.

NFPA PROJECTS: Technical Committees for the Life Safety Code (SAF-AAC) and Building Code (BLD-AAC); Technical Committee on Uniform Fire Code (UFC-AAA); IFMA; AEBO Section.

Recommendation 27. NIST recommends that building codes should incorporate a provision that requires building owners to retain documents, including supporting calculations and test data, related to building design, construction, maintenance and modifications over the entire life of the building⁴⁵. Means should be developed for offsite storage and maintenance of the documents. In addition, NIST recommends that relevant building information should be made available in suitably designed hard copy or electronic format for use by emergency responders. Such information should be easily accessible by responders during emergencies.

NFPA Comment: The retention of documents— including as built drawings, relevant calculations and O&M manuals is important for future modifications or work on the building. What type, and how much information should be available to first responders will be a function of the extent to which government entities adapt to items in Recommendations 15 and 23. Local issues with regard to information required by first responders, the format of the information, and how much information is necessary must also need to be addressed.

NFPA PROJECTS: Technical Committee on Fire and Emergency Service Organization and Deployment — Career (FAC-AAA); Technical Committee on Fire and Emergency Service Organization and Deployment — Volunteer (FAD-AAA); Technical Committee on Fire Service Occupational Safety (FIX-AAA); Technical Committee on Pre-Incident Planning (PIP-AAA); Fire Service Section; Metro Chiefs.

Recommendation 28. NIST recommend that the role of the “Design Professional in Responsible Charge”⁴⁶ should be clarified to ensure that: (1) all appropriate design professionals (including, e.g., the fire protection engineer) are part of the design team providing the standard of care when designing buildings employing innovative or unusual fire safety systems⁴⁷, and (2) all appropriate design professionals (including, e.g., the structural engineer and the fire protection engineer) are part of the design team providing the standard of care when designing the structure to resist fires, in buildings that employ innovative or unusual structural and fire safety systems.

NFPA Comment: Use of all appropriate design professionals should be integrated into this recommendation. Unusual structural design applications must be overseen by a structural engineer; unusual mechanical design applications must be overseen by a

mechanical engineer. Codes should continue to advance the concept of *Design Professional in Responsible Charge*, or *Registered Design Professional*, but state licensing boards should be responsible for establishing the areas of practice for a given project.

Recommendation 29. NIST recommends that continuing education curricula should be developed and programs should be implemented for training fire protection engineers and architects in structural engineering principles and design, and training structural engineers, architects and fire protection engineers in modern fire protection principles and technologies, including fire-resistance design of structures.

NFPA Comment: This recommendation embraces a concept that is long overdue. In some case, fire safety needs and concerns are addressed almost as an afterthought. Fire protection engineers want to offer solutions to everyday prescriptive-based designs but also to innovative architectural designs. Likewise, it is important for the architectural community to be aware of the limits in fire protection engineering. Work among affiliated groups such as NFPA, SFPE, AIA, NCSEA and ASCE among others would help with the cross knowledge application desired by this recommendation.

NFPA PROJECTS: Professional Development Division.

Recommendation 30. NIST recommends that academic, professional short-course, and web based training materials in the use of computational fire dynamics and thermo-structural analysis tools should be developed and delivered to strengthen the base of available technical capabilities and human resources.

NFPA Comment: Such course offering currently exist and broader availability of these programs will help everyone to perform more concise analyses of buildings designs with respect to fire events. Work among affiliated groups such as NFPA, SFPE, AIA, NCSEA and ASCE among others would help with the cross knowledge application desired by this recommendation.

NFPA PROJECTS: Fire Science and Technology Educators Section

Subject: NFPA COMMENTS WTC STUDY
From: "Solomon, Robert" <rsolomon@NFPA.org>
To: <wtc@nist.gov>

WTC Technical Information Repository
Attention: Mr. Stephen Cauffman
National Institute of Standards and Technology
Stop 8610
Gaithersburg, MD 20899-8610

Mr. Cauffman:

Later today, you will be receiving a transmittal letter from NFPA with paper copies of our comments along with a CD. The information was sent for overnight delivery yesterday (3 August 2005). I am also emailing the comments to you as well in the enclosure.

I will also be sending you a supplemental email on two of the recommendations (25 and 26) that I didn't incorporate in the initial submission. I didn't realize that until last night.

Please contact me by email if you have any questions.

Robert Solomon, PE
National Fire Protection Association



NFPA COMMENTS TO NIST ON THE TECHNICAL INVESTIGATION OF THE WTC.doc



NFPA WTC NCSTAR INFO sorted.doc



NIST-Comments on NCSTAR 1-7 Appendix C.doc

NFPA INFO

SPECIFIC COMMENTS ON NCSTAR DOCUMENTS

REF	NCSTAR REPORT #	PAGE	PAR	COMMENT	REASON	REVISION
1	xlvii	Third Bullet, Last Sentence	Beginning of sentence is truncated	Editorial	"Technical and standards barriers to the introduction..."	
1	8	top line	Incorrect spelling of authors name.		Rita Fahy	
1	57	Last Paragraph, 2nd to Last Sentence	Reference should be "NFPA 5000"	Editorial	"...would have satisfied NFPA 5000 requirements..."	
1	183	3rd Bullet, 2nd Sentence	Beginning of sentence is truncated	Editorial	"2001. The manually operated..."	
1	183	Section 8.4.2, 4th bullet point, 3rd sentence	Not clear	It sounds like only 11 people were below the impact point when WTC 2 collapsed.	"Eleven occupants located below the impact point in WTC 2 prior to the attack on WTC 1 were killed."	
1	184	3rd bullet point, 2nd sentence	Again here is the assumption that the group of people seen in the stairs shortly before WTC 2 collapsed had come down past the 78th floor after WTC2 was hit.	There is no basis for this assumption, and there is actually ample evidence that this is not the case.	Delete the second sentence.	
1	184	8th bullet point		The causal model does not contribute much to understanding what influenced people's experiences during the evacuation.	Explain better why experiencing cues before initiating evacuation would cause increased evacuation times. Explain why the interdependence of the variables could be ignored in the analysis.	

REF	NCSTAR REPORT #	PAGE	PAR	COMMENT	REASON	REVISION
				<p>to the impact? And did the analysis that concluded that encountering environmental cues increased their evacuation time only look at cues encountered during evacuation? Why would cues encountered before beginning evacuation cause longer delay times? Isn't it more likely that it was the distance they had to travel that increased their evacuation time?</p>	<p>"It is estimated that 1,000 of the occupants of the towers on September 11th had a limitation...."</p>	
1	185	7th bullet point		<p>It says that 1,000 of the surviving occupants had a limitation. The analysis in NCSTAR 1-7 was using six percent of the building occupancy (over 16,000 people) on September 11th to come up with 1,000. Six percent of the survivors would be a number lower than 1,000.</p>	<p>This point is inconsistent with the analysis in NCSTAR 1-7.</p>	
1	188	4th bullet point, last sentence		<p>Says that notification that Stairwell A was passable should have been relayed. Who would have been in a position to relay that information, since</p>	<p>The point of this bullet item is that available information wasn't pooled and relayed to occupants. The condition of Stairwell A at the 78th floor isn't a valid example of</p>	<p>Delete mention of Stairwell A as an example.</p>

REF	NCSTAR REPORT #	PAGE	PAR	COMMENT	REASON	REVISION
1		193	3rd Bullet	<p>emergency responders never knew? Also, the stairwell was intact, not necessarily passable.</p> <p>The report states that “There were, and are, no field application and inspection requirements to ensure that the as-built condition of the passive fire protection, such as SFRM, conformed to conditions found in fire resistance tests of building components and assemblies...” This is not the case. Today, NFPA 5000, Section 40.5 requires that the registered design professional responsible for design prepare a quality assurance program for sprayed fire-resistive materials used in the building.</p>	<p>information here since the information wasn't available to emergency responders, so it couldn't have been relayed.</p> <p>Inaccurate statement</p>	<p>“There were, and are, no field application...”</p>
1		201	Rec # 1 202	This is a rather substantial long term goal for the structural engineering and material standards communities that may have limited application to new buildings with a higher level of risk. The	Simply to point out the extraordinary coordination and research that will be necessary to execute this recommendation.	None.

REF	NCSTAR REPORT #	PAGE	PAR	COMMENT	REASON	REVISION
1		203	Rec # 2	<p>This is a rather substantial medium term goal for the structural engineering community that may have limited application to new buildings with a higher level of risk. The application and design methodology will need to be developed by the structural engineering community as part of ASCE 7 or a new document. Once the appropriate requirements have been developed, it is anticipated that it will be adopted in NFPA 5000 through a mandatory reference to the latest editions of ASCE 7 and the associated material standards.</p>	<p>Simply to point out the extraordinary coordination and research that will be necessary to execute this recommendation.</p>	None.

REF	NCSTAR REPORT #	PAGE	PAR	COMMENT	REASON	REVISION
1	203	Rec #3	edition of ASCE 7.	Simply to point out the extraordinary coordination and research that will be necessary to execute this recommendation.	None.	
	204		This is a rather substantial medium term goal for the structural engineering community with application to a broad cross-section of new buildings. The requirements will need to be developed and coordinated by the structural engineering and materials communities as part of their design documents. Once the appropriate requirements have been developed, it is anticipated that it will be adopted in NFPA 5000 through a mandatory reference to the latest edition of these documents.	This is a long term goal. Extensive research will be needed to evaluate alternative types of construction and fire ratings. In many instances, the necessary data simply is not available. Task Groups associated with the development of NFPA	Simply to point out the extraordinary coordination and research that will be necessary to execute this recommendation. Also, until a meaningful data collection method is developed, this will be a difficult challenge to overcome.	
1	204	Rec 4			None.	
	205					

REF	NCSTAR REPORT #	PAGE	PAR	COMMENT	REASON	REVISION
				5000 have tried to address these issues and have been extremely frustrated by the lack of research and data associated with construction classifications and the height and area requirements found in current model building codes. The next edition of NFPA 5000, 2006, will contain a new alternate approach to height and area requirements based upon compartmentation principle.		
1	204	Recommendation 4, footnote 21		Data necessary to do this sort of analysis of fire incidents is not collected.	Changes in NFIRS dropped some of the reporting necessary to do this sort of analysis for structure fires.	
1	206	Rec 12		NFPA concurs with the recommendation of enhancing the performance of active fire protection systems to levels consistent the greater risks identified in the recommendation.	The comment recognizes that reasonable designs have been accomplished based on anticipated design basis, and that the establishment performance consistent with the risk is already addressed and being given further attention.	NONE

REF	NCSTAR REPORT #	PAGE	PAR	COMMENT	REASON	REVISION
				<p>information provided in the project report 1-4 and 1-4C, the design of the WTC 1 and WTC 2 fire alarm systems did include significant and realistic enhancements for performance and redundancy in upgrading the fire alarm system after the bombing incident in 1993.</p> <p>Among other things, the fire alarm circuit performance requirements appear to have used the highest performance levels (circuit styles) recognized in the National Fire Alarm Code, addressing single point failures to a significant degree. The events of September 11, 2001 go far beyond what would have been reasonable and realistically expected to be addressed in the system design.</p> <p>The National Fire Alarm Code already recognizes</p>		

REF	NCSTAR REPORT #	PAGE	PAR	COMMENT	REASON	REVISION
				<p>that the degree of performance must be determined by an evaluation of the risks. However, in recognition that greater guidance might be warranted, the need for a joint task to address performance (reliability) issues based on occupancy types and hazards has recently been identified by the NFPA Technical Correlating Committee on Signaling Systems for the Protection of Life and Property. Further the same committee has already established a task group on Mass Notification Systems and proposals have been introduced to provide guidance for these types of systems. Since fire alarm systems may be used in conjunction with events broader than just fires, the work of these task groups will likely evolve and consider a much the broader range of risks than are normally considered for</p>		

REF	NCSTAR REPORT #	PAGE	PAR	COMMENT	REASON	REVISION
1	207	Rec # 7		<p>fire alarm systems.</p> <p>This short term goal has actually been accomplished in the 2006 edition of NFPA 5000.</p> <p>NFPA 5000, Section 7.2.1.1 (2006 edition) requires that all types of rated construction be in accordance with Section 7.2.7, Fire Resistance Rating Requirements for Structural Elements.</p> <p>Proposal 5000-327(Log#106) was submitted by Richard Bukowski, NIST, and 'accepted in principal' by BLD-BLC. The only modification made by the committee was that the very last reference to 'columns' was originally recommended to be 'members'. Per the committee statement, the committee did not believe that a generic reference to 'members' was clear enough in intent. The section now reads:</p> <p>7.2.7.2.3 Structural elements such as girders,</p>	<p>Provided updated information as it is found in the 2006 edition of NFPA 5000.</p>	<p>Update final report to reflect this change.</p>

REF	NCSTAR REPORT #	PAGE	PAR	COMMENT	REASON	REVISION
				beams, trusses, and spandrels having direct connections to columns carrying gravity loads and are essential to the stability of the building as a whole shall have a fire resistance rating not less than that of the columns to which they are connected.		
1	207	Rec # 8		It is not clear how ASCE 7, AISC Specifications, ACI 318 would be involved in the implementation of this recommendation.	If possible, provide a more explicit explanation of the impact of the these documents.	None
1	207	Rec # 9		This is a rather substantial long term goal for the structural engineering and material standards communities that may have limited application to new buildings with a higher level of risk. The application and design methodology will need to be developed by those communities. Once their documents have developed and integrated this methodology, it is anticipated that it will be adopted in NFPA 5000	While PBD options exist in NFPA 101 and NFPA 5000, along with specified goals and objectives, those goals and objectives would likely have to be modified to fit the performance levels described in this recommendation.	None.

REF	NCSTAR REPORT #	PAGE	PAR	COMMENT	REASON	REVISION
1	209 210	Rec 14	through a mandatory reference to the latest editions of ASCE 7 and the associated material standards.	NFPA concurs with the concept that control panels at fire/emergency command stations in building should be adapted to provide useful information from active fire protection systems to aid responders in making tactical decisions. As in the case of Recommendation 13, the degree to which this information is needed and provided must be consistent with the needs and risks of the facility, and be established in concert with the Fire Safety Plan. In addition caution must be used regarding the extent that information is accepted and interpreted by the control panel. The possibility of misinterpretation considering the range of events that could occur	The comment recognizes that the degree of information needed for emergency responders will vary depending on the risks and hazards for each application and that evolving requirements and guidance already exist.	NONE

REF	NCSTAR REPORT #	PAGE	PAR	COMMENT	REASON	REVISION
				must be considered along with the added potential complexity introduced for responders.		
1	209	Rec 13		As noted in the comment for Recommendation 13, the National Fire Alarm Code already includes requirements for the design of a Standard Fire Service Interface, and guidance for Mass Notification Systems has been proposed.	NFPA concurs with the concept that fire alarm and communications systems could (and perhaps should in some cases) be developed to include information on the status of life safety conditions for the effective management and response to fire and other emergencies. It is noted that what constitutes "the status of life safety conditions" (aside from the status of active fire protection systems addressed in	NONE

REF	NCSTAR REPORT #	PAGE	PAR	COMMENT	REASON	REVISION
				<p>recommendation 14) can be subject to a broad range of conditions depending on the facility and the events intended to be addressed.</p> <p>The criteria for the development of these features should be consistent with the needs and risks for a particular facility as noted in Recommendation 12. These criteria should be established in concert with the development of the facilities' Fire (Emergency) Safety Plan and consider the range of events expected to be addressed. It is noted that in the case of the WTC 1 and WTC 2 fire alarm systems the means to initiate occupant notification was achieved manually (rather than norm of automatic initiation) in accordance with the building Fire Safety Plan.</p>		

REF	NCSTAR REPORT #	PAGE	PAR	COMMENT	REASON	REVISION
				<p>The National Fire Alarm Code already includes requirements for the design of a Standard Fire Service Interface that was introduced in concept by NIST. The requirement states: “Where required by the authority having jurisdiction, annunciators, information display systems, and controls for portions of the fire alarm system provided for use by the fire service shall be designed, arranged, and located in accordance with the requirements of the organizations intended to use the equipment.” Detailed guidance for the development of this interface is provided in related annex material and the industrial continues to refine this guidance. The development of guidance for Mass Notification Systems noted in the response to Recommendation 12</p>		

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				may also play a role in the effective management and response to fire and other emergencies.		
				With regard to need for pre-installed dedicated firefighter telephone service, a task group of the NFPA Technical Correlating Committee on Signaling Systems for the Protection of Life and Property has been established to address the subject of two-way communication service, including radio communication systems. Proposals on this subject have already been introduced for the next edition of the National Fire Alarm Code.		
1	209	Rec 12		Add references to NFPA 14, NFPA 20 NFPA 70, NFPA 92A, NFPA 92B and NFPA 110	These documents all contain requirements that were discussed within the specific reports. Specifically, requirements for standpipes, fire pumps and emergency power supplies.	Add references to: NFPA 14 NFPA 20 NFPA 70 NFPA 92A NFPA 92B NFPA 110
1	210	Rec. 15		NFPA concurs with the	The comment recognizes that	NONE

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				<p>concept that systems could (and perhaps should in some cases) be developed to provide real-time off-site secure transmission of valuable information for emergency responders. The degree to which this information is needed and provided must be consistent with the needs and risks of the facility, and be established in concert with the Fire Safety Plan. However the need to preserve this information for subsequent investigations is more questionable, especially for the vast majority of installation.</p> <p>As noted in the comment for Recommendation 13, the National Fire Alarm Code already includes requirements for the design of a Standard Fire Service Interface, and guidance for Mass Notification Systems has been proposed. These</p>	<p>the degree of information needed for emergency responders will vary depending on the risks and hazards for each application and that evolving requirements and guidance already exist. It is not likely that the vast majority of installations would benefit from requirements for deliberate preservation of this information.</p>	

REF	NCSTAR REPORT #	PAGE	PAR	COMMENT	REASON	REVISION
1		Rec 17	211	<p>systems have the potential to evolve in a manner that will facilitate the transmission of information off-site as needed for the particular application. As a consequence of the technologies used, preservation of the information may also be accomplished as a byproduct.</p> <p>1. The words “to accommodate TIMELY full building evacuation of occupants” result in a recommendation that is too general to be understood and implemented. NIST should better define what it means by “tall buildings” (for example, >20 stories as used in Recommendation 4). If NIST is not able to recommend the acceptable full evacuation time for a building dependent on number of stories, it should provide guidance</p>	<p>NIST recommends that tall buildings should be designed to accommodate timely full building evacuation of occupants due to building-specific or large-scale emergencies such as widespread power outages, major earthquakes, tornadoes, hurricane without sufficient advanced warning, fires, and accidental explosions;and terrorist attack.</p> <p>1. The recommendation is not helpful. It does say whether the egress system sizing criteria of the current model codes are inadequate or what “timely” means. NIST needs to present a recommendation that can serve as a starting point for a SDO to consider.</p> <p>2. It is not a reasonable use of resources to require the egress system to be designed to accommodate full building evacuation after a terrorist attack that produces an assault to the building that would be greater than that from power outages, major earthquakes, tornadoes,</p>	

REF	NCSTAR REPORT #	PAGE	PAR	COMMENT	REASON	REVISION
				<p>on the analysis needed to answer the question for a particular building.</p> <p>2. If a "terrorist attack" involves an assault to the building that would be greater than that from "power outages, major earthquakes, tornadoes, hurricane without sufficient advanced warning, fires, accidental explosions," it is not reasonable to require the egress system to be sized to accommodate full building evacuation after such terrorist attack.</p>	<p>hurricane without sufficient advanced warning, fires, and accidental explosions. Steps need to be taken to prevent the terrorist attack at the building perimeter. If the perimeter protection is compromised, such as by a collision from an airplane, the other systems should not be expected to do anything more than can be expected from power outages, major earthquakes, tornadoes, hurricane without sufficient advanced warning, fires, and accidental explosions.</p>	<p><u>Stairwell and exit capacity</u> Stair and stair discharge door capacity should be adequate to accommodate counterflow due to emergency access by responders.</p>
1	211	Rec # 17 Last sentence of main paragraph		The recommendation to accommodate counterflow for emergency responders is needed.	NFPA has codified the counterflow issue in NFPA 101-2006 and NFPA 5000-2006 by specifying the minimum widths needed for counterflow (on the stair and at the stair enclosure discharge door). Given that recommendation 17 relates mainly to full evacuation, NIST's recommendation that "stairwell and egress CAPACITY" (not just width) be increased is worth pursuing.	

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1	211	Rec 16,	Part b	<p>Delete ", and that elevators can be used if they are still in service and haven't been recalled or stopped."</p> <p>As written, the last phrase in part (b) seems to contradict the preceding phrase, and could create confusion. The use of ordinary elevators during an emergency evacuation should be controlled or supervised and should be one of the things that evacuees would potentially be explicitly instructed to do by on-site incident commanders. If all building occupants wait for elevators, the evacuation will can take much longer as shown in NIST's own research.</p> <p>If the elevators go out of service during the emergency, occupants on upper floors will not know that, and may continue to wait, jeopardizing their safety. <u>[It is expected that a new generation of elevators will provide real-time information in the elevator lobbies on each floor as to operating status of the elevator, expected wait times, and other needed information, but today's elevators lack such features.]</u> If the elevators are used under supervision, occupants with</p>	<p>Replace deleted phrase with a separate explanatory sentence that describes what those instructions might be: "In some cases, elevators (regular elevators?) can be used if they are still in service and haven't been recalled or stopped. Use of such elevators should be spelled out in the building's evacuation plans and should be restricted to those with mobility impairments <u>or</u> otherwise unable to use the stairs, and under the supervision of on-site incident commanders."</p>	

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				<p>mobility impairments or otherwise unable to use the stairs can be efficiently assisted from upper floors.</p> <p>Evacuation of other occupants can be expedited, if the fire or building officials on scene determine that it could be done effectively.</p>	<p>NFPA 101 requires stair signage for both new and existing stairs serving five or more stories. Roof access or the lack thereof must be designated by a sign that reads ROOF ACCESS OR NO ROOF ACCESS. NFPA 5000 requires similar signage for new construction. The required signage can be used in the training recommended by NIST.</p>	<p>Qualify the statement – to the degree possible, mobility challenged occupants should be provided a means for self-evacuation...</p>
1	211	Recommendation 17 (b) first sentence	There will be people for whom self-evacuation will never an option.	<p>There was a man killed on September 11th who had an electric wheelchair with a ventilator attached and was accompanied full-time by an aide. He couldn't be transferred to an evac chair.</p> <p>How would he ever be able to self-evacuate?</p>		

REF	NCSTAR REPORT #	PAGE	PAR	COMMENT	REASON	REVISION
1	212	Rec 18		The recommendation is needed.	<p>Exit access remoteness and exit remoteness need further study. The placement of exit stairs within the core of a building should not be discounted provided an acceptable level of remoteness can be achieved.</p> <p>NFPA 101 and NFPA 5000 permit remoteness to be measured via what NIST refers to as the "walking path" where such path is provided by a minimum 1-hr corridor system. The NFPA provision is based on smoke and fire spread considerations. In view of the need to protect against more than fire, the method of measuring remoteness needs further study.</p> <p>NFPA 101 and NFPA 5000 currently credit scissor stairs as providing only one exit, but the width of scissor stairs is credited for purposes of capacity considerations.</p> <p>NFPA 101 and NFPA 5000 have exit and directional-exit sign provisions, as well as</p>	None

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				requirements for special stair signage that provide both occupants and emergency responders with needed information. This is particularly important in tall buildings where the exit stairs are not normally used, and building occupants travel via elevators.		
1		213	Rec 19	NFPA concurs with the concept of providing accurate, coordinated and timely emergency information for emergency responders and building occupants as indicated in Recommendation 19. The degree to which this information is provided must be consistent with the needs and risks of the facility, and be established in concert with the Fire Safety Plan.	The comment recognizes that the degree of information needed will vary depending on the risks and hazards for each application and that guidance has already begun to be developed.	<p>NONE</p> <p>As noted in the comment for Recommendation 13, guidance for Mass Notification Systems has already been proposed for the National Fire</p>

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1	214	Rec 20		<p>Alarm Code. Many of the features and considerations described in the recommendation have been considered in the development of the proposed guidance. This guidance is likely to be ongoing and evolve over time as the understanding of these needs matures.</p> <p>The recommendation is needed, but the term “stairwell navigation devices” should be changed to “stair descent devices.”</p>	<p>NFPA 101-2006 and NFPA 5000-2006 will offer significant guidance on the use of “stair descent devices” for moving persons with mobility impairments on stairs. The term “stair descent devices” better describes the product.</p>	<p>NIST recommends that the full range of current and next generation evacuation technologies should be evaluated for future use, including protected/hardened elevators, exterior escape devices, and stairwell <u>navigational devices</u> stair descent devices, which may allow all occupants an equal opportunity for evacuation and facilitate emergency response access.</p> <p>A task group of ASME A17 is currently studying the feasibility of protected/hardened elevators and NFPA is participating in that effort. Once the hazard analysis portion of the project has been completed, NFPA 101 and NFPA 5000 are expected to address the associated construction</p>

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1	214	Rec 20		The recommendation is needed, but the term “stairwell navigation devices” should be changed to “stair descent devices.”	NFPA 101-2006 and NFPA 5000-2006 will offer significant guidance on the use of “stair descent devices” for moving persons with mobility impairments on stairs. The term “stair descent devices” better describes the product.	NIST recommends that the full range of current and next generation evacuation technologies should be evaluated for future use, including protected/hardened elevators, exterior escape devices, and stairwell <ins>navigation devices</ins> stair descent devices, which may allow all occupants an equal opportunity for evacuation and facilitate emergency response access.

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				associated construction details.		
1	214	Rec 21		<p>The recommendation is needed, but subitem "a" should be deleted.</p> <p>A task group of ASME A17 is currently studying the feasibility of protected/hardened elevators and NFPA is participating in that effort. The process is well into a comprehensive hazard analysis.</p> <p>Subitem "a" is inconsistent with the general nature of the overall recommendation. The entire subject needs considerable study before jumping ahead to one specific recommendation. The subitem is confusing in its use of the term "remote release of elevator cabs by</p>	<p>NIST recommends the installation of fire-protected and structurally hardened elevators ... procedures and protocols.</p> <p>a. The requirement for remote release of elevator cabs by emergency response personnel should be included in the ASME A17-1 Safety Code for Elevators and Escalators:</p>	

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				emergency personnel." Most emergency responders would object to some other emergency responder "releasing" an elevator that the first crew has taken under Phase 2 operation to a floor. Even if that is not what the recommendation's authors meant, it is best to delete the line for now until the ASME task group has completed its hazard analysis. For this recommendation it is best to keep the big picture in mind and let the details shake out as they will.	Currently NFPA 25 requires that the original records for the water based systems be retained for the life of the system. While the model codes may not contain these requirements the report should also recommend that the state and local jurisdictions adopt and enforce the requirements of NFPA 25.	Add reference to NFPA 25 requirements on records retention for water based fire protection systems.
1	217	Rec 27.		Add reference to retention of system information which is currently required by such documents as NFPA 25.		
1	217	Rec # 27		This is a medium term goal with application to new, nonresidential buildings.	None	None

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1-1	iii	Finding 7	Please clarify which United Kingdom document incorporates progressive collapse design requirements for all buildings.	Clarity.	Add document name.	
1-1	iii	Finding 8	ASTM E1996 is not an appropriate test standard for determining the structural integrity of stairway/elevator cores and, therefore, should not be mentioned.	The scope of ASTM E1996 states the following: "This specification covers exterior windows, glazed curtain walls, doors and impact protective systems used in buildings located in geographic regions that are prone to hurricanes."	Delete reference to ASTM E1996 and recommend that an appropriate test standard be developed for this situation.	
1-1	iv	Finding 14	The 2006 edition of NFPA 5000 contains this language now. See our response to NCSTAR 1, Recommendation 7.	Language needs to be updated to reflect current edition of NFPA 5000.	Update final report to reflect this change.	
1-1	142 143	Section on 'Construction Classification'	The Types of Construction should be presented in Roman Numerals. Also, Type III construction is considered "ordinary"; while, Type V construction is considered "combustible".	Incorrect presentation of Types of Construction classifications. Also, Type I and Type II construction allow the inclusion of limited-combustible structural elements – they are not solely limited to noncombustible materials. Type V construction is not solely limited to traditional wood frame construction.	1. "The main categories are Type II (fire resistive), Type II2 (non-combustible), Type III3 (ordinary/combustible), Type IV4 (heavy timber), and Type V5 (combustible/ordinary)." Modify numbers throughout the remaining section. 2. "Type IV5 is all other types of construction, including traditional wood frame construction. 3. "In some codes, these sub-	

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				categories are identified by letters following the type (e.g., 1B or 3A) or by a set of three numbers that represent the fire resistance required (in hours) of the exterior bearing walls; columns, beams, girders, trusses and arches, supporting bearing walls, columns, or loads from more than one floor; and floor construction columns, beams, and floors, respectively (e.g., Type I(332) 1 [3,3,2])."	4. Comparisons between the different types of construction in the various model codes may be simplified by including the following table: (Table shown at end of comments)	"If a building qualifies for more than one construction classification, such as Class 1A or Class 1B, all of the model building codes require only that it meet the requirements of the least type of construction do not say which classification should be used." NFPA 5000, Section 7.2.1.2 (2003 edition) states the
1-1	144	2nd Paragraph	Inaccurate statement – "If a building qualifies for more than one construction classification, such as Class 1A or Class 1B, all of the building codes do not say which classification should be used."	Inaccurate statement.		

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				following:		
			7.2.1.2 Except as permitted by other provisions of this Code, whenever two or more types of construction are used in the same building, the entire building shall be classified as the least type of construction in the building and shall be subject to the requirements for that type.	7.2.1.2 Except as permitted by other provisions of this Code, whenever two or more types of construction are used in the same building, the entire building shall be classified as the least type of construction in the building and shall be subject to the requirements for that type.	"with modifications for the presence of fire sprinklers and sufficient open perimeter."	
1-1	145	2ND Paragraph		Do not recognize open perimeter modifications.	Incomplete statement	
1-1	145	2ND Paragraph		Why is only IBC quoted here? What is the purpose of introducing modern model codes here?	Section seems a bit unorganized	Include a reference to Section 8.2 of NFPA 5000.
1-1 A	3	2nd Paragraph, 1st Sentence		Explain the difference between the "second and third" drafts of the NYCBC.	Unclear the significance of the two different drafts.	Clarify the difference.
1-1 B	7	3rd Paragraph, 1st Sentence		Truncated word	Editorial	: "... provisions are written in terms of"

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	1-1 F	Whole Document		Why does this report use the 2003 edition of the BCNYC, when all other reports use the 2001 NYCBC?	Inconsistent	Modify this report to reflect the requirements of the 2001 edition of the NYCBC.
1-2 A	8	Figure 1-8	Lower right box is missing text	Editorial	Replace missing text.	
1-3	xxxvii	3rd Paragraph	The last two goals are not numbered.	Editorial	Add numbers to entire list.	
1-3	11	2nd Paragraph	Figure is incorrectly referenced in body of document – Figure 2-8 does not show an assembled floor panel before the concrete floor was poured.	Editorial	Correct sentence	
1-4	XXXi	7 th Bullet from the top of the page	Change reference to NFPA 14 from NFPA 13.	Correct reference to standpipe standard.	Change reference to NFPA 14 from NFPA 13.	
1-4	xxxii	First bullet of E.3 /sentences 1-2	Although the context of the finding is presented more clearly than in Report 1-4C, the sentences could still be misleading.	It appears that design of the system not the events of September 11, 2001 required manual activation. Presumably the signal delay was not caused by a system fault but by a delay in signal transmission by operating staff (fire safety plan).	Revise the sentences to read: "Because the design of the WTC 1 and WTC 2 fire alarm systems required manual activation of the alarm signal to notify building occupants, the alarm signal was not transmitted until 12 min after the impact in WTC1."	NFPA 13-2002 ed.
1-4	10	Paragraph 3/sentences 1	Correct NFPA 13 reference to 2002 edition from 2004 edition.	Fix editorial error.		
1-4	11	Paragraph 1/sentences 3	Correct NFPA 13 reference to 2002 edition	Fix editorial error.	NFPA 13-2002 ed.	

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				from 2004 edition.		
1-4	11	Paragraph 4/sentences 2		Correct NFPA 14 reference to 2003 edition from 2004 edition.	Fix editorial error.	NFPA 14-2003 ed.
1-4	51	Last paragraph / last sentence	The statement is misleading.	The disparity in performance (circuit styles) between the different circuits is acknowledged and may have played some role in the overall performance variability. However the stated conclusion does not appear to be supported by a clear explanation in the report of how the circuit disparities caused the (unspecified) observed variability of performance. Other factors may have played a more significant role. It is worth noting that the highest level of performance established by the available styles of circuits appears to have been used.	Revise to read: "The disparity of performance between the different types of circuits may have played a role in the variability in performance of the fire alarms after impact."	
1-4	64	Entire page.	The material organization is confusing.	The organization of the material is not consistent with that in report 1-4C page 104.	Revise in accordance with report 1-4C.	
1-4	67	Second bullet of 4.6/sentences 1-2	Although the context of the finding is presented more clearly than in Report 1-4C, the sentences could still be	It appears that design of the system not the events of September 11, 2001 required manual activation. Presumably the signal delay was not caused by a system	Revise the sentences to read: "The design of the WTC 1 and WTC 2 fire alarm systems required manual activation of the alarm signal to notify building occupants. This was	

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				misleading.	fault but by a delay in signal transmission by operating staff (fire safety plan).	not accomplished until 12 min after the impact in WTC1."
1-4	67	Third bullet of 4.6 /sentences 1-2	Although the statements are true it should be noted that the highest levels circuit performance were provided consistent with NFPA 72 circuit performance (styles).	The statements made could imply that this disparity is unique to the WTC 1 and WTC 2 fire alarm systems.	Add the following sentence: It should be noted that the highest levels of circuit performance were provided consistent with NFPA 72 circuit performance (styles).	
1-4	67	Fourth bullet of 4.6/sentence 1	The sentence is misleading.	Telephone circuits are required to meet performance standards. The current edition of NFPA 72 addresses these in 6.9.9.	Delete Sentence.	
1-4	95	Section 6.1.2; first, second and third bullets.	Refer to comments provided for page 67, Section 4.6 second, third and fourth bullets.	Refer to reason for comments provided for page 67, Section 4.6 second, third and fourth bullets.	Refer to suggested revision provided for page 67, Section 4.6 second, third and fourth bullets.	
1-4C	xxxii	Intro par. of E.6/sentence 1	The phrase "but not all functions performed as intended" is misleading.	The phrase suggests that the system either didn't perform as intended by its designers or that it didn't perform as intended for the events of September 11, 2001. The evidence in the report does not appear to suggest that the system operation was less than expected by its designers. The intended performance for the catastrophic events of September 11, 2001 was not	Replace the phrase with "but the system performance was reduced by the catastrophic events of September 11, 2001 that were not part of the design basis of the system."	

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1-4C	xxxii	Intro par. of E.6/sentence 2	The sentence is misleading.	In the context of the first sentence, the second sentence suggests that analyzed performance was that of the system on September 11, 2001. However it appears to be largely based on an evaluation of the design of the system aside from the events of September 11, 2001.	part of the design basis.	Replace the sentence with "The analysis of the fire alarm system's design has led to the following observations."
1-4C	xxxii	Second bullet of E.6/sentences 1-2	The sentences could be misleading.	It appears that design of the system not the events of September 11, 2001 required manual activation. Presumably the signal delay was not caused by a system fault but by a delay in signal transmission by operating staff (fire safety plan).	Revise the sentences to read: "The design of the WTC 1 and WTC 2 fire alarm systems required manual activation of the alarm signal to notify building occupants. This was not accomplished until 12 min after the impact in WTC1."	Revise the sentences to read: "The design of the WTC 1 and WTC 2 fire alarm systems required manual activation of the alarm signal to notify building occupants. This was not accomplished until 12 min after the impact in WTC1."
1-4C	xxxii	Fourth bullet of E.6/sentence 2	The sentence is misleading.	Telephone circuits are required to meet performance standards. The current edition of NFPA 72 addresses these in 6.9.9.	Delete Sentence.	
1-4C	106	Second bullet of 6.2.1/sentences 1-2	The sentences could be misleading.	It appears that design of the system not the events of September 11, 2001 required manual activation. Presumably the signal delay was not caused by a system fault but by a delay in signal transmission by operating	Revise the sentences to read: "The design of the WTC 1 and WTC 2 fire alarm systems required manual activation of the alarm signal to notify building occupants. This was not accomplished until 12 min after the impact in WTC1."	Revise the sentences to read: "The design of the WTC 1 and WTC 2 fire alarm systems required manual activation of the alarm signal to notify building occupants. This was not accomplished until 12 min after the impact in WTC1."

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	1-5 B	124	2 nd and 3 rd Paragraphs	Jump into modern model building code requirements seems abrupt. Also, NFPA 5000, Chapter 40 dictates that the acceptable thickness of SFRM is as tested in accordance with ASTM E 605. This section should present the requirements of ASTM E 605.	Provides reader with additional information.	Add minimum thickness requirements from ASTM E 605.
	1-6	Ixxii	Finding 6	Misspelled word and truncated sentence.	Editorial	Match the language found in Finding 6, page 315.
	1-6	Ixxiii	Finding 19	Doesn't match Finding 19 on page 316.	Editorial	Match the language found in Finding 19 on page 316.
1-6 A	5	Section 2.2	6	Type III construction is considered "ordinary"; while, Type V construction is considered "combustible".	Correction	<p>Modify the following:</p> <ol style="list-style-type: none"> 1. "The main categories are Type I (fire resistive), Type II (non-combustible), Type III (ordinary combustible), Type IV (heavy timber), and Type V (combustible ordinary)." 2. "In some codes, these sub-categories are identified by letters following the type (e.g., 1B or 3A) or by a set of three numbers that represent the fire resistance required (in hours) of the exterior bearing walls;

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				<p>columns, beams, girders, trusses and arches, supporting bearing walls, columns, or loads from more than one floor; and floor construction elements, beams, and floors,, respectively (e.g., Type I(32) 1-3-2) (NFPA 5000 2003)."</p> <p>3. Comparisons between the different types of construction in the various model codes may be simplified by including the following table: (Table at end of Comments)</p>	<p>Modify the following:</p> <ol style="list-style-type: none"> 1. "The main categories are Type I (fire resistive), Type II (non-combustible), Type III (ordinary combustible), Type IV (heavy timber), and Type V (combustible and ordinary)." 	
1-6 A	xxxii	Construction Types	Type III construction is considered "ordinary"; while, Type V construction is considered "combustible".	Corrections to section on Construction Types.	<ol style="list-style-type: none"> 1. "The main categories are Type I (fire resistive), Type II (non-combustible), Type III (ordinary combustible), Type IV (heavy timber), and Type V (combustible and ordinary)." 2. "In some codes, these sub-categories are identified by letters following the type (e.g., 1B or 3A) or by a set of three numbers that represent the fire resistance required (in hours) of the <u>exterior bearing walls</u>; <u>columns, beams, girders,</u> <u>trusses and arches, supporting bearing walls, columns, or</u> 	

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				Loads from more than one floor; and floor construction columns, beams, and floors, respectively (e.g., Type I(332) 1{3,3,2}).	loads from more than one floor; and floor construction columns, beams, and floors, respectively (e.g., Type I(332) 1{3,3,2}).	
1-6 A	6	Section 2.3, 3 rd Paragraph	Insert "5000" after NFPA in two places.	Editorial	"For example, the NFPA 5000, Building Construction and Safety Code, (NFPA 5000, 2003)..."	
1-7	Throughout		The term 'normalized stairwell travel time' is confusing and should be replaced throughout. What's meant is 'flight (or story) traversal time'	Reason for Comment: Stairwell travel time is the time it takes to move down the stairs. What was done in the report is divide time in the stairs by the number of floors.	Throughout the report, replace the term 'normalized stairwell travel time' with a less confusing term, such as 'flight (or story) traversal time.'	
1-7	various			Somewhere on the lower floors of WTC1 there was a group of mobility-challenged occupants. That location is reported inconsistently in different reports. NCSTAR 1-7 page xxxv, second line: between 12 and 20.	Revise the final report to use a consistent location.	
				NCSTAR 1 pages 156 and 185: 12 th	Contradictions throughout report on the number of	
				NCSTAR 1-8 page 10, says 'on about the 12 th floor'		
1-7	various (see reason)					

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		(column)		people killed in WTC2 who initially were below the impact floors.	Page xxxiv paragraph 1, second line from the bottom – 11	
				Page xxxv, sixth line from top – 7 Page 114, 3 rd paragraph, 3 rd line – seven Page 120, Table 9-2 – 11	Page xxxiv paragraph 1, second line from the bottom – 11 Page 114, 3 rd paragraph, 3 rd line – seven Page 120, Table 9-2 – 11	1) Page 32, Sec 2.2.3, fourth line – delete mention of 240 elevators in complex – it's irrelevant and the enumerating of elevators is already confusing enough 2) Page 32, Sec 2.2.3, fifth line – are these 7 elevators the ones that are described as freight elevators on page 34? If so, they served the towers, not just the basement levels. 3) Page 122, 5th page, 1st line – says there were 99 elevators

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				in each tower – there were more, but I'm not sure how many	4) Page 34 – there were three sets of 24 local elevators (total – 72), three types of express elevators (8 to 44th, 10 to 78th and 2 to restaurant or observation deck – total 20), seven freight elevators – that seems to be the 99 elevators frequently mentioned. They also mention five other local elevators in each tower. Car #09 is mentioned twice – once with the freight elevators and again in the next paragraph as one of the local elevators.	
1-7	xxxii and 63	Description of focus group 4	delete 'non-traditional occupants'	wording is awkward and potentially derogatory – better phrased elsewhere; these people were as much building occupants as any office worker.	"Persons with building responsibilities, to capture the unique perspective of custodians, security, maintenance, or other building staff."	
1-7	xxxiii	Paragraph 2, line 5	Inconsistent number of fatalities	Contradicts Tables 4-1 and 9-2.	Estimated number of deaths was 2,146 to 2163.	
1-7	xxxv	end of first paragraph	This assumption appears several times in the report and there is no basis for it. "...a large group of occupants from above the impact floors may have identified the	There's no basis for this assumption. There are other possible explanations and there is information available that makes this explanation highly unlikely. Three men who managed to escape past	Change to "...a large group of occupants from above the impact floors may have been making their way out of the building as it collapsed."	

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				passable stairwell (Stairwell A) and may have been making their way out of the building as it collapsed.”	the 78 th floor in that stairwell had great difficulty. One was badly burned. None reported being followed down the stairs. It is more likely that a group of people got below the 78 th floor before WTC2 was struck, but delayed somewhere on a lower floor too long and didn’t make it out of the building before it collapsed.	(1) Either the reference (NFPA, 1912) is the wrong format, or the listing in the reference page is wrong – it was hard to find. (2) “The Equitable Building was a group of five buildings linked together, ...”
1-7	2	1 st paragraph, first two sentences		Reference and description aren’t clear	Inaccuracies	Delete “The wall coverings had complete burned out when the fire department arrived on the floor, only seven minutes after notification” – I can’t find that in the article at all.
1-7	4	Top paragraph		There are a lot of inaccuracies introduced into this description of the fire. There are details that aren’t in the referenced article.		Corrections to text: “The intense black smoke quickly trapped most of the approximately 40 occupants on the floor of origin. Many occupants found refuge in offices and closed the doors

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					behind them, breaking out windows to vent incoming smoke and waited to be rescued. At some point, one woman jumped from a 6 th floor window and sustained severe injuries. The fire department was notified when an occupant of the building from another floor activated a manual pull station at approximately 10:30 a.m. Several occupants of the <u>fire</u> floor were leaning out of a broken 6 th floor window in order to breathe..."	
1-7	21	label for Floor 43, 45-47	typo	he Skylobby was on the 44 th floor, not the 45 th floor. Didn't the escalator connect the 43 rd and 44 th floors, rather than the 44 th and 45 th ? (On page 34 there's mention of an elevator from the cafeteria on the 43 rd floor to the Skylobby on the 44 th .)		
1-7	22	left column, middle row	What about the 79 th floor?	Doesn't appear on any of the plans.	Need to identify Floor 79.	
1-7	33	Figure 2-14 and discussion of figure in top line	Is this the right figure? Figure 2-14 doesn't show anything about space taken by Elevator Bank A or show Elevators 24-29.	1) find a better way to explain how the reclamation of floor space is shown on this figure, or insert a more relevant figure. 2) on the graph, move the		

REF	NCSTAR REPORT #	PAGE	PAR	COMMENT	REASON	REVISION
				pointers to local elevators to their appropriate starting positions on lobby levels.		
1-7	36	Fire Command Station	Question -- was the fire command station staffed at all times? The section on page 38 about the responsibilities of the fire safety director says that that individual is required to be on duty during normal working hours, but is that at the fire command station, or does that person report to the fire command station when necessary?	When trying to understand the emergency plan , that's a detail that would help.	Just mention in the Fire Command Station whether or not it was staffed during normal business hours, and by whom.	
1-7	38	Bottom line		This is the first mention of a police desk, and it seems to be distinct from the Fire Command Station and the Operations Control Center. Where was this police desk? It's mentioned in a couple of places in these few places.	Need a clarification if the police desk and FCC are separate and distinct.	
1-7	40	Floor Warden System		Two questions: 1) each floor had to have a floor warden, but on multi-tenanted floors, didn't each tenant have to have a floor warden? I	Not clear on procedure for floor wardens	If multi-tenanted floors had multiple floor wardens, say so. Explain why the floor wardens had to call the police first.

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				thought the rule was that every tenant had to have a floor warden, and tenants on multiple floors had to have a floor warden on each floor. (2) The floor wardens were supposed to call the police desk (wherever that was) before reporting the incident to the Fire Command Station?		
1-7	41	Last full paragraph at the bottom		(1) first sentence: clarify whether occupants were only told what the procedure was, or were they told to perform the procedure as part of the drill. It's not clear if evacuating three floors was actually supposed to be done as part of the drills, and in the telephone interviews, some people had gone down stairs in drills and others didn't seem to have. (2) Everything after the first sentence is interesting, but it doesn't belong here. It isn't about occupant training.	Clarity	(1) clarify drill procedure; (2) move that text to the section that has the description of the stairwells (Section 2.2.2)
1-7	45	Ever where WTC2		Replace 'passable' with After WTC2 was struck,	After WTC2 was struck,	Replace 'passable' with 'intact'

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		Lines 3 and 5	Stairway A is described as passable (in all documents)	'intact'	Stairway A may have been intact structurally, but two people found themselves unable to pass the 78th floor (and are probably among the dead). Three men did make it past the 78th floor, against the advice of those two people, but the fire conditions they encountered, and the fact that no one followed them down the stairs, implies that the stairway was not 'passable' although it may have been 'intact.'	when describing the condition of Stairway A after WTC2 was struck, in all documents.
1-7		50 and thereabouts	Description of the badge list	Nowhere is the badge list described in terms of how current it was or how many names were on it, in total, for WTC1 and WTC2.	The badge list was the basis for the telephone survey sampling. It seems to have been used to estimate the population in the building, although that isn't clear. (That's another comment.) If it was out of date, that would also explain some of the difficulty in contacting people for the survey.	<ol style="list-style-type: none"> 1) mention how current the badge list was. Since, obviously, it wasn't a list that was kept on-site, was it out-of-date (on September 11th)? 2) How many names were on the list? The list was used to estimate the number of people in the towers on September 11th, but there's no mention of the total number of people on the list.
1-7	51	Discussion of Representativeness of Badge List		1) The reference for the CNN web site is not given, and should include the date it was taken. The list was updated over time, and the currently posted list may be	The analysis is a comparison between the media or CNN lists and the badge list – do mismatches mean that individuals were definitely not supposed to be there? Does this support the conspiracy	<ol style="list-style-type: none"> 1) Add reference for CNN web site: 2) Explain the methodology for the comparison with the media list – who was

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				<p>different.</p> <p>2) Don't understand the procedure was comparing media list with badge list – why check only 144 names? How were they chosen ?</p> <p>33) 3rd paragraph on page 51, Tables 3-1 and 3-2 – what does it mean that people “were definitely not supposed to be at WTC 1 or WTC 2 the day of the tragedy....”</p>	<p>theorists?? Who were these people??</p> <p>This is just a test of representativeness. What was the reasoning behind the methodology? Isn't it possible that the badge list was out-of-date, and that's why people who apparently were killed in the towers didn't appear on the list, rather than that they <i>definitely weren't supposed to be there?</i></p>	
1-7	52			<p>Discussion of telephone sample selection bullets</p>	<p>These terms need clearer definitions</p> <p>The website referenced on Table 3-4 doesn't provide sufficient explanation,</p>	<p>1) 2nd bullet point – is this the ‘eligible’ group described later? What was the basis for this estimate? Was the assumption that 86 percent of the people on the badge list were killed or absent on 9/11?</p>
1-7	53		bottom two paragraphs	Typos?	Inconsistent with other sections	<p>1) 4th para – Here and in NCSTAR 1-7B, page 16, the percentage of unlocatable phone numbers is 76.7 in the text and 76.6 in the tables.</p> <p>2) 5th para, 5th line – subjects are ‘unlockable’ here and ‘unloadable’ in NCSTAR 1-7B, page 15. Should be</p>

REF	NCSTAR REPORT #	PAGE	PAR	COMMENT	REASON	REVISION
1-7	54	1st paragraph, 3rd sentence	Numbers in parentheses don't match Table 3-3. This text doesn't appear in NCSTAR 1-7B.	If this isn't an error, there's no indication of where these numbers come from.	'unlocatable'?	Should read "Third, the badge list included decedent names (0.7 percent) – some from the September 11, 2001, attack (0.3 percent) and others from causes not necessarily related to September 11, 2001 (e.g., cause unknown, natural causes, 0.4 percent)."
1-7	54 55	Table 3-4 (page 55) and discussion in last two paragraphs on page 54.	(1) Not clear how eligibility was calculated, or what the difference is between eligibility and overall rates. (2) The footnote on Table 3-4 should not be to the weblink, since this document is described as a work in progress. The link currently is the 3rd edition – is that the version this authors used? In the referenced document, the correct citation is given and should be used here.	The explanation of how the telephone sample was collected is not clear, as was mentioned in an earlier comment (specifically concerning the lack of detail about the badge list). The lack of clarity continues here, and there is no additional information in NCSTAR 1-7B. The footnote for Table 3-4 says that the disposition rate definitions are 'consistent' with the AAPOR standards, but the referenced website is not helpful in understanding what the definitions used here actually are.	1) The screening rate is calculated as the proportion of names with initial phone numbers that were NOT 'can't contact/locate' or 'other refusal' or 'language barrier.' But, the text says that it's the percentage of successful telephone contacts – that would be a percentage rate twice as high as shown. Should read "approximately 46 percent of initial telephone numbers that resulted in successful telephone contacts determining whether the potential respondent was present..."	Define the categories of people that make up the 'interview' category. There's no explanation of how that rate is calculated and it's not clear from the numbers shown in Table 3-3. The 'overall'

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				category is the product of the 'screening' rate and the 'interview' rate, but there's no explanation of what that means. What is the 'eligible' response rate and how is it calculated? How and why does that differ from the 'overall' response rate?		
1-7	63	Last sentence	Unclear; better phrased in NCSTAR 1-7B	cCarthy: 'notes taken in duplicate' sounds like copies and that's not how it was done.	"Two notetakers recorded the discussion and notes were later compiled into a single summary of the focus group."	
1-7	67	2nd paragraph, 3rd sentence	The text states that the response rate analysis in Section 3.2.2 'leads directly' to a projection of the number of people present during the attacks.	Nowhere in this report is that calculation explained, and the discussion in Section 3.2.2, which is unclear as to how the response rate was calculated, does not 'lead directly' to any calculation of number of people present	Detail how this calculation was done. The estimate of people present appears throughout the investigation reports and deserves a paragraph or two of explanation.	
1-7	76, 78, 82, 85, 105 and 113	Tables 5-1, 5-2, 6-2, 6-6, 8-1 and Table 8-3	n=440 – how is that correct?	There were 427 subjects in WTC1, so n shouldn't be greater than 427.	Correct the n value, or explain where the extra observations came from.	
1-7	83	Bottom paragraph, second sentence; Table 6-4; and anywhere throughout where perception of risk is discussed. (Page 93, bottom paragraph and Table 6-12)	Using the term 'perception of risk' obscures the power of the questions actually asked.	When people read about 'perception of risk,' they can be left asking 'risk of what?' -- injury, death, entrapment? The survey asked people twice each for themselves and others around them – did they think they or others were in danger of being killed. This is a powerful question and given how many people	Before very specific that the question survivors' perception of risk to themselves and others was risk of death, not some vague feeling of danger.	

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				answered in the affirmative, it gives an indication of how great people's perception of the danger was.		
1-7	84 90	Page 84, bottom line; page 90, 9th line.	Cubicle misspelled 'cubical'	Typo		
1-7	86	2nd paragraph, 1st sentence	This sentence says that damage on the 22nd floor is mentioned several times in NCSTAR 1-7A, but that's not accurate.	Wrong reference.	I'm not sure what the authors are referring to here. There is mention of damage on floors in NCSTAR 1-7A, but not specifically the 22nd floor. Are they actually referring to the matrix? The matrix is not part of that document. Rather than NCSTAR 1-7A, should the reference be 'Fahy and Proulx, 2003,' which is the reference to the database used elsewhere?	
1-7	101	Figure 7-3	This figure isn't helpful in showing the damage.	The legend uses plan boxes to describe two different things (partitions and structural damage); the stairwell locations aren't shown.	Show location of stairwells, since this was crucial in the evacuation of a handful of people from above impact. Use a legend that explains what the boxes are. (Only 'floor system removed' is clear; the other boxes are identical.)	
1-7	106	1st paragraph, 25th line, starting 'Only the staircase furthest away...'	Refers to Stairwell A as 'passable' and says severe damage is shown in Figure 7-1.	'Passable' is a misleading word and Figure 7-1 doesn't show any damage to Stairwell A.	1) Change 'passable' to 'intact' or 'relatively intact' for this context. 2) Either use a figure that shows damage to Stairwell A, or delete reference to Stairwell A.	

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1-7	114	3rd paragraph, 3rd line	More contradictory mentions of the number of people killed in WTC2 who initially were below the impact; was it 11 or 7? Page 114, 3rd paragraph, 3rd line – seven Page 120, Table 9-2 – 11	The sections should have the same numbers.		
1-7	114 167	114, 3rd paragraph, sentence 2-5; page 167, top of page	This repeated suggestion that there were more people traveling down from above the impact point in WTC 2 should be deleted.	This suggestion, which appears in more than one place, is not convincingly substantiated. The authors assume that the people observed in the stairwell shortly before the collapse must have passed the point of impact. This contradicts the observations of three people who DID come from above the 78th floor after impact. Their descriptions of the blockage in the stairs, and the smoke/fire conditions, make it sound very unlikely that a large group of people had been moving down the stairs after them. A more likely explanation is the this was a group of people who left the upper floors before impact and were resting/waiting on a lower floor, and waited too long to continue their evacuation.	Delete this discussion – there are other possible explanations (as the authors state), so there's no point in advancing this one as the most likely. In fact, there is plenty of reason to doubt that it is correct.	
1-7	115	1st paragraph, 1st	624-680 occupants is	Contradicts reporting in	"...many of the 630 to 684	

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1-7	120	sentence	wrong	Table 9-2	occupants..."	Simply state that this is an assumption, given no other information. Report what is known; don't make assumptions about the rest.
1-7	121	5th and 6th bullet points in the middle of the page	These two bullet points don't belong in the list.	This section is enumerating the number of people 'known' to be killed below the impact points. These two points are describing people whose locations were never determined. These people are the reason that the number of deaths are reported as a range.	After the 4th bullet point, "In addition, there were up to 24 individuals who were somewhere in the building, but may have been above or below impact regions in either building and another 17 individuals for whom no information could be located."	After the 4th bullet point, "In addition, there were up to 24 individuals who were somewhere in the building, but may have been above or below impact regions in either building and another 17 individuals for whom no information could be located."
1-7	121	3rd and 4th bullet points at the bottom of the page	These two bullet points don't belong in the list.	This section is enumerating the number of people 'known' to be killed at or above the impact points. These two points are describing people whose locations were never determined. These people are the reason that the number of deaths are reported as a range.	After the 2nd bullet point, "In addition, there were up to 24 individuals who were somewhere in the building, but may have been above or below impact regions in either building and another 17 individuals for whom no information could be located."	After the 2nd bullet point, "In addition, there were up to 24 individuals who were somewhere in the building, but may have been above or below impact regions in either building and another 17 individuals for whom no information could be located."
1-7	121	Middle paragraph, last sentence	Delete this sentence	People were still alive above the impact points when the	Delete this sentence	Delete this sentence

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			(“Assuming that all of these individuals were alive at the time that his or her respective building....”	towers collapsed. This sentence doesn't add anything to the discussion, and is inaccurate.		
1-7	121	1st sentence in section at the bottom.	individuals were “at from above”	typo	Believe this is supposed to be “at or above” the floors of impact.	
1-7	122	Header at the top of the page	Delete “Estimated” from the title of this section	The number of passengers and crew is known, not estimated.	Delete the word ‘Estimated’ from the title of this section.	
					Also, the sentence just before Section 9.2.1 isn't related to the number of passengers and crew. Maybe the section at the top of the page should be titled “Other Victims”, so that the people in the planes and the people outside the building fit logically in the same section.	
1-7	122	5th paragraph, 1st sentence	There were more than 99 elevators in each tower.	The correct number of elevators should be used in this discussion.	Use the correct number of elevators. Some of the victims might have been building staff in freight elevators.	
1-7	128	Last paragraph, sentences 4-5	Awkward and inaccurate phrasing.	Initiating evacuation and choosing to initiate evacuation are not the same thing, and would have occurred at different points in time, as evacuation is defined in this report.	“In WTC 2, over 90 percent of the occupants (meaning survivors?) began to evacuate before their building was attacked.”	
1-7	132	Paragraph 2, sentence 4	This sentence says “Floor also increased	Contradictory statements	Did floor increase or decrease time to begin evacuation?	

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				delay in starting evacuation...." On page 134, it says "In both towers, floor's effect was negative, that is, the more floors one was from the exit, the quicker people were to initiate their evacuation."		
1-7	134	1st paragraph, sentence 9 (3rd sentence from the end)		On page 128 (and elsewhere), the report states that evacuation initiation delay increased with building height (meaning floor the respondent was on). Here, the report says that higher a person was in the building, the quicker people were to initiate their evacuation.	Contradictory statements	Did location at impact increase or decrease delay times? Be consistent. (These results are repeated in several places.)
1-7	135	10.2.2		"Normalized stairwell evacuation time" is a poor term for what is actually the average number of seconds per flight of stairs, apparently calculated as the floor of origin divided by travel time.	Evacuation time is generally taken to mean total duration – in this case, it would seem to mean travel time in the stairs. There are already enough conflicting definitions of 'evacuation time' in the literature without introducing another one. The authors are talking about number of seconds per flight – use a term that clearly means number of	Replace throughout with a more accurate term, such as 'average flight traversal time.'

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1-7	138	First paragraph	Not enough explanation of what this all means	seconds per flight.	Need more explanation to make this analysis meaningful and/or useful.	Explain why environmental cues would make a person travel the stairs faster or slower. The environmental cues reported by the subject could have been the smoke, fire, etc., observed when the building was struck. Why would that have any impact on travel time in the stairs? The analysis is restricted to only the data sought in the questions (obviously), but there is at least one serious omission here logically in that fatigue is never mentioned as being a potential factor in one's travel time. Explain why this analysis has any value or meaning when environmental cues before egress are used but physiological factors like fatigue excluded.
1-7	160	1st sentence	Since the investigation didn't determine how many of the victims below the impacts had a mobility impairment, it isn't appropriate to determine that they were not over-represented in the decedent population.		Conclusions made without sufficient evidence.	Delete this comment since the condition of these victims hasn't been determined. CDC is beginning a project that will look at the victims from below the impact points in order to try to determine why these individuals died. Their mobility will be of major interest in that

REF	NCSTAR REPORT #	PAGE	PAR	COMMENT	REASON	REVISION
					study.	
1-7	160	paragraph 3, sentence 2	The egress modeling appears in Appendix D.	Typo	Change Appendix E to Appendix D.	
1-7	160	Section 10.4	Should mention that all of the evacuation model were used well beyond the limitations for which they were validated.	None of the models here were validated using 110-story structures. Using any model beyond the limits for which it was designed is potentially problematic, not that the analysis isn't interesting, but this should be mentioned..	Just mention this as a limitation of the analysis.	
1-7	165	Section 11.1, 1st and 2nd bullet points	The ranges for number of deaths in each tower doesn't match what's reported in Tables 4-1 and 9-2 or on page 115, and possibly elsewhere.	Different numbers for number victims appear throughout the report	First bullet point should probably be 1,462-1,533. Second bullet point should probably be 630-701.	
1-7	166	4th and 5th bullet points on this page	Neither of these points appears anywhere in this report.	The findings section shouldn't include material that hasn't been discussed in the report. Neither of these two points appear in the analysis of the relevant questions or discussion. While it's true that some people delayed or interrupted their evacuation (this was reported by survivors themselves), what is the basis for concluding that that explains all the deaths of those	1) time per floor should be discussed in the report where stairwell travel is covered. 2) in 5th bullet point, delete “resulting in over 100 deaths below the impact region.”	

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				originally from below the impact points? What about those who were trapped, injured or had serious mobility impairments?		
1-7	167	Section 11.3, first bullet point	something is wrong with the first sentence “caused people out to find...”	Typo?	Don’t know what they’re trying to say here.	
1-7	167	2nd bullet point	1) second sentence again says that floor increased delay and refers to Section 10, which says that floor decreased delay. 2) 3rd sentence says that observation of environmental cues increased the amount of time people spent in the stairs – this is based on regression analysis, which does not determine cause and effect.	1) contradictory statements; 2) regression analysis is used to indicate which variables are good predictions of the dependent variable in the equation. Regression analysis does not determine that one variable has a cause and effect relationship with that other variable. The variables used in this regression analysis are so interdependent it is wrong to conclude, as stated here, that observation of environmental cues increased time spent in the stairs. (How, exactly, could that even be the case – a person sees smoke and fire out the window, and it makes him slower in the stairs? Doesn’t it make more sense that a person on a higher floor was more likely to see fire and smoke and, being on a higher floor,	Eliminate the contradictory statements throughout the report. Explain in more detail what contribution the causal analysis made to the findings in the study, given that key variables explaining long evacuation time (e.g., fatigue) were not available.	

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				required more time to travel down the stairs, resulting in more fatigue and more interference from crowding thus, more time in the stairs?) 3) It wasn't really necessary to use a causal model to determine that any interruption in the process of evacuation would increase evacuation time.		Delete "Contrary to the perceptions of the occupants," – the point of the analysis was to show that other factors had more of an impact on increased evacuation times.
1-7	167	Bullet point at the bottom.	"Contrary to the perceptions of the occupants, ..." Nowhere in the report did occupants report a perception that firefighters increased their total evacuation time. They were asked in the telephone interview if any of a list of factors made their evacuation more difficult while in the building. Saying yes to firefighters or police moving up the stairs doesn't mean that they were saying that their total travel time was impacted significantly. (44 percent said they were helped by police or firefighters – in the media accounts, it was clear that the firefighters			

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				who helped were the firefighters encountered in the stairs.)		
1-7	168	1st bullet point	This is essentially the same as a paragraph that appears on the previous page.		Delete one of the duplicate paragraphs.	
1-7	169	Section 11.5, 2nd bullet point	The location of the mobility-challenged evacuees is reported here to have been 'somewhere between floors 12 and 20' – this needs to be reported consistently throughout the report.	Inconsistent throughout the report	Appears elsewhere as: NCSTAR 1-7 page xxxv, second line: between 12 and 20 NCSTAR 1 pages 156 and 185; 12th	NCSTAR 1-8 page 10, says 'on about the 12th floor'
1-7	241	Table D-2, description of Zone 2	There was an escalator between floors 44 and 45 and between 43 and 45?	On page 21 it says that there was an escalator between 44 and 45. I thought that was a typo (the Skylobby wasn't the 45th floor). These descriptions of elevators should be checked and should match.	Replace here and on page 21 with whatever is correct.	

NCSTAR REPORT 1-1 COMMENTS FOP P. 142-143 AND NCSTAR REPORT 1-6A P. 5-6

Table A.7.2.1.1 Cross-Reference of Building Construction Types

NFPA 5000 and 220	I(442)	I(332)	II(222)	II(111)	II(000)	III(211)	III(200)	IV(2HH)	V(111)	V(000)
UBC	—	I FR	II FR	II 1 hour	II N	III 1 hour	III N	IV HT	V 1 hour	V-N
B/NBC	1A	1B	2A	2B	2C	3A	3B	4	5A	5B
SBC	I	II	—	IV 1 hour	IV unp	V 1 hour	V unp	III	VI 1 hour	VI unp
IBC	—	IA	IB	IIA	IIB	IIA	IIB	IV	VA	VB

unp: Unprotected.

[Source: NFPA 5000, Table A.7.2.1.1]

Subject: NFPA SUPPLEMENTAL COMMENTS-RECOMMENDATIONS 25 AND 26
From: "Solomon, Robert" <rsolomon@NFPA.org>
To: <wtc@nist.gov>

WTC Technical Information Repository
Attention: Mr. Stephen Cauffman
National Institute of Standards and Technology
Stop 8610
Gaithersburg, MD 20899-8610

Mr. Cauffman:

Here are the two comments I mentioned in my first email. These are in addition to the comments you received in the previous email and that you will receive via hard copy and CD today.

Robert Solomon, PE
National Fire Protection Association



Rec 25 STAFF COMMENTS ON NIST WTC STUDY.doc



Rec 26 STAFF COMMENTS ON NIST WTC STUDY.doc

NFPA COMMENTS ON NIST WTC STUDY

NAME: NFPA

Report Number: NIST NCSTAR 1,WTC Investigation

Page Number: 216

Paragraph/Sentence: paragraph 9.2.7 / Recommendation 25

Comment:

Address governmental entities in the Recommendation. Cite the importance of qualified design, construction, and inspection professionals in ensuring safety in buildings.

Reason for Comment:

Though the Recommendation refers to non-governmental and quasi-governmental entities that own or lease buildings not being subject to building and fire safety requirements, governmental entities often exempt the buildings they own or lease from building and fire regulations.

We concur with the need for third party inspection during construction and operation of the building. Licensing and certification of engineers, architects, designers, and inspectors helps ensure that people are qualified to design, construct, and inspect buildings. Design , construction management, field inspections, and plan reviews should only be performed by qualified individuals.

Building owners may opt for construction project review and oversight by an independent engineer or architect on a contractual basis or use qualified professionals (licensed or certified) in their employ. Designs and as-built conditions should be reviewed by code inspectors in the local jurisdiction for compliance with building and fire regulations.

We concur that contractors should not be permitted to self certify their work in lieu of third party code enforcement inspections.

Suggestion for Revision:

Recommendation 25. Entities that own or lease buildings and are not subject to building and fire safety code requirements of any governmental jurisdiction must be concerned about the safety of the building occupants and the responding emergency personnel. NIST recommends that such entities should be encouraged to provide a level of safety that equals or exceeds the level of safety that would be provided by strict compliance with the code requirements of an appropriate governmental jurisdiction. To gain broad public confidence in the safety of such buildings, NIST further recommends that it is important that as-designed and as-built safety be certified by a qualified third party Engineers, architects, designers, contractors, construction managers and code inspectors should be qualified through certification or licensure to perform their functions. Engineers, architects, designers, contractors, construction managers and building owners should not use self-certification or self-approval of their work or materials for code enforcement purposes in areas including interpretation of code provisions, design approval, product acceptance, certification of the final construction, and post-occupancy inspections over the life of the buildings.

NFPA COMMENTS ON NIST WTC STUDY

NAME: NFPA

Report Number: NCSTAR 1

Page Number: 217

Paragraph/Sentence: Recommendation 26: (paragraph 2/sentences 2-4)

Revise first “non-bold” sentence in recommendation that includes a list of codes addressing the needs of existing buildings (see below).

Add new sentence to the end of recommendation (see below).

Comment:

1. Add reference to NFPA 5000, Chapter 15.
2. Stress retroactive sprinkler high-rise building provision included in NFPA 1, Uniform Fire Code.

Reason for Comment:

Current list of codes is incomplete without NFPA 5000, Chapter 15 (that chapter is equivalent to the information included in the recommendation for the International Existing Buildings Code).

Since focus of this investigation is the protection of high-rise buildings, emphasis should be made that NFPA 1 is the only model code that requires the retroactive installation of sprinklers in all high-rise buildings.

Suggestion for Revision:

Revised sentence:

Provisions related to egress and sprinkler requirements in existing buildings are available in such codes as the *International Existing Buildings Code (IEBC)*, *International Fire Code*, NFPA 1, NFPA 101, chapter 15 of NFPA 5000 and ASME A 17.3.

Add new sentence:

NFPA 1 is the only model code that requires the retroactive installation of sprinklers in all high-rise buildings regardless of occupancy.